

THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXXV, Pt. 1]

JULY 1, 1952

[No. 5

A Review of the Frogs and Toads of Costa Rica

BY

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Abstract: The present known salientian fauna of Costa Rica is reviewed and descriptions are given for the species known to occur in the country. Illustrations of numerous species are given.

The following new forms are described: *Hyla alvaradoi*, *Hyla rivularis*, *Hyla immensa*, *Hyla rufioculis*, *Hyla alleei*, *Hyla debilis*, *Hyla wellmanorum*, *Hyla angustilineata*, *Hyla moraviaensis*, *Bufo holdridgei*, *Cochranella talamancae*, *Atelopus senex*, *Atelopus varius loomisi*, *Atelopus varius ambulatorius*, *Microbatrachylus rearki*, *Microbatrachylus costaricensis*, *Eleutherodactylus dubitus*, *Eleutherodactylus crassidigitus*.

Bufo gabbi, a new name, is given for *Bufo auritus* Cope (*nec. Bufo auritus* Raddi). In the genus *Microbatrachylus* are placed certain forms (*polyptychus*, *underwoodi*, *bransfordii*, and *stejnegerianus*) heretofore regarded as belonging to the genera *Hylodes*, *Lithodytes* or *Eleutherodactylus*.

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INTRODUCTION

The present work concerning the frogs and toads is the third of a series treating of the herpetological fauna of Costa Rica. The first dealing with the snake fauna appeared in 1951.[°] The second dealing with the salamander and caecilian fauna appeared in 1952.^{°°} The material on which the present work is based is that of Richard C. Taylor, and that collected by me for the University of Kansas in 1947. This has been augmented by a second collection obtained by me in Costa Rica in 1951.

A report on the extent of the 1947 collections and localities visited appears in the preceding works. The localities at which collections were made in 1951, in some measure duplicate those of 1947; but the greater number of collecting localities was different.

Arriving in San José by air on June 24, 1951, after an uneventful flight, I completed the formalities at the customs, and moved on to Turrialba on June 26. Here at the Inter-American Institute of Agricultural Sciences I established my headquarters, thanks to the courtesy of the director, Dr. Ralph Allee.

From here journeys were made to the slopes of the Volcanoes Barba, Poás and Irazú; to the eastern slope of the northern part of the Talamanca Range, and to the summit of the peak of Cerro de la Muerte. A number of days were spent at Moravia, the great finca of Don Fernando Alvarado-Chacon; at Bataan, the abaca plantations; and at Los Diamantes in the eastern lowlands. An outbreak of yellow fever in the northern lowlands prevented a journey planned to explore the San Carlos region of northern Costa Rica.

The greatest amount of effort in 1951 was devoted to securing amphibians and to this end night sorties were made on approximately two thirds of the nights between July 26 and September 14. This resulted in the discovery of certain new forms and the collecting of considerable numbers of known forms. The region, seemingly richest in species, was that about Moravia. Here in four days collecting 38 species were taken of which 21 were amphibians, six of which were new to my Costa Rican collection.

I am uncertain as to what time of the year one might expect to find the greatest number of species breeding. During the period from the middle of June to September breeding choruses or eggs were found of *Bufo marinus*, *Hyla elaeochroa* and *Cochranella*

[°] A Brief Review of the Snakes of Costa Rica. Univ. Kansas Sci. Bull., vol. 34 pt. 1, 1951, Oct. 1, pp. 1-188, pls. 1-23, text figs. 1-7.

^{°°} The Salamanders and Caecilians of Costa Rica. Univ. Kansas Sci. Bull., vol. 34, pt. 2, Feb. 15, 1952, pp. 695-791; pls. LXXXVI-LXXXVIII; text figs. 1-14.

fleischmanni although groups of males or single males representing numerous species were heard almost every night. After a time a collector comes to recognize most of these calls. However, a number of unrecognized calls, chiefly from high forest trees, suggest the possibility of still other undiscovered species.

In some cases there is doubt as to the application of names. Several of the Cope types are missing and it is not impossible that I have been influenced by names placed on specimens in certain museums.

The list of Central American type specimens mostly from Costa Rica that at one time may have been in the United States National Museum, but which cannot be found today, is as follows:*

<i>Ollotis coerulescens</i>	<i>Hylella chrysops</i>
<i>Crepidius epioticus</i>	<i>Hyla cherrei</i>
<i>Lithodytes florulentus</i>	<i>Hyla microcephala</i>
<i>Lithodytes habenatus</i>	<i>Hyla p. monticola</i>
<i>Lithodytes muricinus</i>	<i>Hyla p. moesta</i>
<i>Hylodes stejnegerianus</i>	<i>Rana chrysoprasina</i>
<i>Leptodactylus quadrivittatus</i>	<i>Hypopachus inguinalis</i>
<i>Dendrobates tinctorius vittatus</i>	

ACKNOWLEDGMENTS

The journey to Costa Rica was made possible by a grant from the University of Kansas Endowment Association, which provided all funds for the undertaking. I am especially grateful for this courtesy. The cordial welcome and assistance of Dr. Ralph Allee, Director of the Inter-American Institute of Agricultural Sciences, is most appreciated. Aside from arranging for my housing facilities, a very adequate laboratory was provided, and he personally contributed specimens, and enlisted the aid of his faculty and workmen to obtain other specimens for me.

Dr. Leslie Holdridge, of the Costa Rican Ministry of Agriculture and of the Inter-American Institute of Agriculture, while I was a guest at his home, provided transportation for visits to the volcanoes of Barba and Poás, where he was pursuing forestry investigations. On these occasions both Dr. Holdridge and his son, Lee Holdridge, collected numerous specimens for me.

I am under deep obligation to Sr. Don Fernando Alvarado-Chacon for the privilege of visiting Moravia. While there I was provided with transportation and shown every possible courtesy, by his manager. To these gentlemen I express my sincere gratitude.

* I am indebted to Dr. Doris Cochran for help in preparing this list.

At Cartago I was permitted to accompany Sr. Mario Gutierrez J. of the Ministry of Agriculture and Mr. John B. Reark, a student of Forestry, on various exploratory journeys to out-of-the-way places in the mountains both north and south of Cartago. I am under special obligation to Mr. Reark for very numerous herpetological specimens that he collected for me.

Others to whom I desire to express my thanks are Sr. Don Claudio Volio, Minister of Agriculture, Sr. Prof. Reubén Torres Rojas, El Conde de Tattenbach, Dr. and Mrs. Frederick Wellman, Mr. Baker, Mr. Johnny Baker, Dr. Juvenal Valerio, Sr. Julio Valerio, Mr. John de Goeijen, Sr. Frank Herrera, Mr. William Lageler and Prof. Marco Tullio Pacheco. To these I am under obligation for specimens, for transportation and other assistance in collecting, and for numerous other courtesies.

The drawings have been made by Mrs. William Halsey, Victor Hogg, Ellinor Loeffelmann, and Thespa Stapoulis.

For the most part they may be regarded as adequate illustrations of the forms described. A few illustrations are taken from other older works and two figures, *Hyla fimbriembra* and *Hyla richardi*, recently published in my own paper, are reprinted here, thanks to the courtesy of the Editors of Copeia.

HISTORY OF COLLECTIONS AND LITERATURE

Literature on the frogs and toads of Costa Rica is scattered in numerous books and journals and much of it is somewhat confused, so much so that the application of the proper name to certain of the forms depends upon a re-examination of the existent types by some competent observer. Many of these type specimens are in European Museums and not of easy access. Others are lost. In this paper certain of the names applied are tentative, pending such an examination.

The known Salientian fauna of Costa Rica is smaller in number of species than the snake fauna, but on the other hand it is much larger than the salamander fauna, the proportion of the three, salamander, Salientia, and snakes, being 1:4:5. While considerable exploration has been done in Costa Rica one can be sure that a considerable number of undiscovered or unrecognized forms remain to be discovered. A rather large percentage of the species is known from unique specimens or from a single collection of two or more specimens at the same time and place.

One of the earlier studies dealing with the fauna of Lower Central America is that of Oscar Schmidt (1857). His specimens were

collected by von Warszewicz in Panamá [New Granada] and Bolivia. Brief Latin descriptions of the species studied by Schmidt appeared first. Later a second, more expanded paper was published with several illustrations. The new species from Central America in the preliminary paper are as follows:

Leiuperus sagittifer, New Granada.

Ixalus warschewitschii, New Granada.

Hyla pugnax, Chiriquí "unweit Bocca del Toro."

Hyla splendens, Chiriquí River "unweit Bocca del Toro."

Hyla molitor, Chiriquí River "unweit Bocca del Toro."

Hyla molitor marmorata, Chiriquí River "unweit Bocca del Toro."

Hylodes fitzingeri, New Granada.

Dendrobates speciosus, New Granada.

Dendrobates pumilio, New Granada.

Dendrobates lugubris, New Granada.

Bufo veraguensis, New Granada, (Veragua) by inference.

Bufo simus, New Granada.

Hylaemorphus Dumerilii, New Granada.

Hylaemorphus Bibroni, New Granada.

Phirix pachydermus, New Granada.

This work of Schmidt was followed by another (Schmidt 1857, "Deliciae Herpetologicae Musei Zoologici Cracoviensis") a considerably longer paper dealing with the same material. While repeating the Latin descriptions, he supplies other considerable data. There is some discussion and greater detail is given concerning the type localities. Three plates, bearing 27 figures, are included.

The first paper dealing exclusively with the Costa Rican herpetological fauna was that of Wilhelm Keferstein (1868). He published on the salientian collection obtained in Costa Rica by Prof. K. von Seebach who was in Costa Rica in 1865, chiefly on a geological journey. The following are described or listed from Costa Rica without more specific locality:

Atelopus varius [Lichenstein and von Martens].

Hypopachus Seebachii Keferstein.

Bufo aqua Latreille.

Bufo (*Chilophryne*) *sternosignatus* Günther.

Bufo (*Rhacbo*) *haematiticus* Cope.

Leiyla Güntherii sp. nov.

Hyla Moreletii Duméril.

Dendrobates typographus Keferstein.

At about this time the U. S. National Museum began to receive specimens from Costa Rica, the collectors being Charles N. Riotte and Doctor Van Patten. The specimens received were forwarded to Edward D. Cope at Philadelphia who had recently begun to publish his numerous papers on the Central American faunas. In his "Fourth Contribution to the Herpetology of Tropical America," (Cope 1866) he describes a new genus and the following new species from Costa Rica:

Genus *Colostethus* gen. nov.

Ranula chrysoprasina sp. nov.

Bufo coccifer sp. nov.

Engystoma variolosum sp. nov.

One other new species, *Phyllobates ridens*, was described from San Juan River, Nicaragua, near the northern border of Costa Rica. The Costa Rican specimens were collected by Charles N. Riotte at a point designated as "Arriba," Costa Rica. No such place name can now be located. It has been suggested by Prof. Reubén Torres that the name is intended for "above," or "up high," perhaps the mountains arising above Cartago or San José. On the other hand it may have been a place name in existence 85 years ago when the collections were made.

Cope continued to study Central American faunas and a series of papers dealing with Costa Rica followed, the more important of which are noted. In (1871) "Ninth Contribution to the Herpetology of Tropical America" he listed from Costa Rica:

Trypheroopsis chrysoprasinus Cope.

Atelopus varius.

Bufo.

Smilisca daudimii (*sic*) Duméril and Bibron.

Agalychnis moreletii Duméril.

These specimens were collected by Dr. Van Patten near San José, Costa Rica.

His most important single work is (Cope 1875) "On the Batrachia and Reptilia of Costa Rica." This was based on a collection made by William Gabb, under the auspices of the government of Costa Rica, chiefly in the southeastern portion of the country. Collections were begun near the eastern seaboard and continued along the route travelled to near the summit of Pico Blanco, a mountain which rises to a height of nearly 12,000 ft. It is a region described by Cope as follows:

"The coast region includes a wide belt of swamps and then gradually rises to a height of two hundred feet at 15 miles inland.

From this point the surface rises rapidly, so that at twenty-five miles the elevation is 2500 feet above the sea. The vegetation of the entire region is exceedingly dense. At an elevation of from 5000 to 7000 feet is the region of greatest precipitation; rain falls here, according to Mr. Gabb, on more than two hundred days of the year and heavy fogs are of daily occurrence. The surface is often covered with a deep layer of moss and swamps abound. There is no belt of pines as in Mexico, but the extreme summits of the peaks are covered with a sparse vegetation consisting chiefly of *Artemesia* much like that of the Rocky Mountain region of the United States, with whortleberries, a bamboo-like grass, a stunted tree fern, and scattered tufts of grass."

The following Salientia are listed:

Cranopsis fastidiosus gen. et sp. nov. Slope of Pico Blanco, 2500 ft.

Crepidius epioticus gen. et sp. nov. Pico Blanco, 5000 ft.

Ollotis coerulescens gen. et sp. nov. Pico Blanco, 3000-5000 ft. elevation.

Bufo auritus sp. nov. East coast region.

Bufo valliceps Wiegmann.

Bufo coccifer Cope.

Bufo sternosignatus Günther (no specimens).

Bufo aqua Daudin. Eastern coast.

Bufo haematiticus Cope. Sipurio.

Hypopachus variolosus Cope.

Atelopus varius Stannius. Pico Blanco Range.

Dendrobates typographus Keferstein (low country).

Dendrobates tinctorius auratus Girard.

Dendrobates talamancae Cope. Old Harbor on East Coast.

Hyla gabbii sp. nov. Near Sipurio.

Hyla uranochroa sp. nov. Near Sipurio.

Hyla nigripes sp. nov. Higher points on Pico Blanco, chiefly in the rainy zone, 5000 to 7000 ft.

Hyla elaeochroa sp. nov. East foot of mountains near Sipurio.

Hyla punctariola pictipes subsp. nov. Pico Blanco, 5000 to 7000 ft.

Hyla punctariola moesta subsp. nov. Pico Blanco, 5000 to 7000 ft.

Hyla punctariola monticola subsp. nov. Pico Blanco, 5000 to 7000 ft.

Smilisca baudinii Duméril and Bibron.

Agalychnis moreletii A. Duméril.

Phyllobates hylaeformis sp. nov. Pico Blanco, 7000 ft.

Liylla guentherii Keferstein (no specimens).

Lithodytes podiciferus sp. nov. Pico Blanco.

Lithodytes muricinus sp. nov. Pico Blanco.

Lithodytes habenatus sp. nov. Pico Blanco.

Lithodytes melanostictus sp. nov. Pico Blanco, 7000 ft.

Lithodytes megacephalus sp. nov. Pico Blanco, 6000 ft.

Lithodytes gulosus sp. nov. Pico Blanco, 6000 ft.

Hylodes cerasinus sp. nov. Pico Blanco.

Gnathophysa ocellata Linnaeus.

Trypheroopsis chrysoprasinus Cope. Uren 2500 ft.

Ranula brevipalmata Cope. Pico Blanco.

Cope's (1877) "Tenth Contribution to the Herpetology of Tropical America," contains the description of *Bufo melanochloris* sp. nov. from east Costa Rica collected by Wm. Gabb. Cope (1875) had at first referred the type specimen to *Bufo valliceps*. Two forms *Lithodytes lanciformis* and *Lithodytes pelviculus* from "West Coast of Central America" are not impossibly from Costa Rica since these names have been synonymized with Costa Rican species.

Cope's (1886) "Thirteenth Contribution to the Herpetology of Tropical America" deals with a collection sent by Dr. J. F. Bransford from Nicaragua. The following are listed:

Hylodes polyptychus sp. nov.

Bufo haematiticus Cope.

Bufo marinus Linnaeus.

Bufo valliceps Wiegmann.

Dendrobates tinctorius Wagler.

Dendrobates typographus Keferstein.

Hypsiboas albomarginata Spix.

Agalychnis helenae Cope.

Lithodytes diastema Cope.

Ranula chrysoprasina Cope.

Engystoma pictiventris sp. nov.

Hyla quinquevittata Cope.

Lithodytes ranoides sp. nov.

All of these species except *Bufo valliceps* are known to occur in Costa Rica, suggesting strongly that the collection was made in southernmost Nicaragua. Two other species are described as new that may or may not occur in Costa Rica. These are, *Hypsiboas miliaris* sp. nov. and *Lithodytes bransfordii* sp. nov. (the latter reported in Costa Rica by Barbour and Dunn, 1921).

In his "Second Addition to the Knowledge of the Batrachia and Reptilia of Costa Rica," Cope (1893) describes four new forms of Salientia and lists several known forms. These are:

Lithodytes florulentus sp. nov. Boruca.

Hylodes stejnegerianus sp. nov. Palmar.

Leptodactylus quadrivittatus, sp. nov. Buenos Ayres.°

Dendrobates tinctorius vittatus subsp. nov. Buenos Ayres.°

Bufo marinus Linnaeus. Buenos Ayres.°

Bufo haematiticus Cope. Rio Grandes, Buenos Ayres.°

Hyla gabbii Cope. Buenos Ayres.° Lagarto.

Hyla nigripes Cope. Buenos Ayres.°

Liophyla ranoides Cope. Terraba, Buenos Ayres.°

Lithodytes rhodopsis Cope. Buenos Ayres.°

Dendrobates tinctorius auratus Girard. Palmar, Talamanca.

Atelopus varius Stannius. Palmar.

Cope's last important paper on this fauna was (1894) "Third Addition to a Knowledge of the Batrachia and Reptilia of Costa Rica." Most of the specimens for this study were sent to Cope by the Museo Nacional de Costa Rica. The collectors of the following specimens were R. Alfaro, Sen. P. Biolley, and G. K. Cherrie.

Hyla cherrei sp. nov. Alajuela.

Hylella chrysops sp. nov. Alajuela, and San José.

Lithodytes euryglossus sp. nov. San José.

Levirana vibicaria new genus and species, Rancho Redondo and Isla Nueva, near the head of the Río Sucio on the Atlantic side.

Oscar Boettger (1892) described *Hyla prosoblepon* from La Junta, near Limón and later (Boettger, 1893) another new species *Hyla fleischmanni* from San José. The specimens were collected by Carl Fleischmann.

G. A. Boulenger published his "Catalogue of the Batrachia Salientia" in 1882, and the Costa Rican material in the British Museum at that time, is listed in this great work. *Phyllomedusa lemur* is described as new from Costa Rica, and *Hylodes palmatus**° is used for certain frogs from Dueñas, Guatemala. In 1891 he described *Bufo leutkenii* from Cartago, Costa Rica and later (Boulenger, 1896) he described *Hylodes underwoodi* and *Hylella puncticus*. A salamander *Spelerpes subpalmata* is also described in the same paper. In 1898 (Boulenger, 1898) he reported a series of eleven

° Spelled "Buenos Aires" on recent maps.

*° Although not so stated *Hylodes palmatus* may be a substitute name for *Leiyla guentherii* Keferstein 1868, presumably preoccupied by *Hylodes Güntheri* Steindachner 1864, at least Boulenger places the Keferstein species in the synonymy of *palmatus*.

species. Much of the Costa Rican material in the British Museum was acquired or collected by Mr. C. F. Underwood. This material is later listed in the work by Günther (1900-1902).

Salientia from the collections of Mission Scientifique au Mexique et dans l'Amérique Centrale, was studied by M. Brocchi who published from 1881-1883. Most of the Costa Rican species listed are those taken from the literature, since the Mission did not collect in the southern part of Central America.

Albert Günther, from February 1900 to May 1902 issued the "Batrachia" section of the "Biologia Centrali-Americana. Reptilia and Batrachia." This great work deals with the Batrachian fauna of Central America (and Mexico) and is perhaps the second most important work on the batrachian fauna of Costa Rica. Approximately 60 species are listed from Costa Rica, most of which were represented in the collections of the British Museum. The presence of five others may be inferred since they occur north and south of Costa Rica. Two species listed (*Hyla godmani* and *Hyla punctariola*) are seemingly questioned as to their occurrence. Many species are figured and the following are listed:

Rana halcina Kalm. Bebedero, San José, La Palma Lagoon to alt. 1500 m.

Rana godmani sp. nov. Río Sucio.

Rana caerulopunctata Steindachner. La Palma 1500 m.

Laevirana vibicaria Cope. Irazú Range and Isla Nueva.

Hylaplesia tinctoria (Schneider). La Palma; Talamanca; Buenos Aires.

Hylaplesia typographa (Keferstein). "Costa Rica."

Hylaplesia talamancae (Cope). "Costa Rica," "Cold Harbour" on the east coast.

Atelopus varius Stannius. Bebedero; Escazú; "Izaru" [= Irazú?]; San Marcos; Tivas (alt. 1000 m.); Santa Clara (alt. 400 m.).

Glossostoma aterrimum sp. nov. "Costa Rica."

Hypopachus variolosus (Cope). Bebedero; San José.

Leptodactylus pentadactylus Laurenti. Eastern Costa Rica; Las Delicias; Santa Clara (400 m.).

Leptodactylus caliginosus Girard. "Costa Rica."

[*Syrrhaphus ridens* (Cope)] reported from Nicaragua and Panamá.

Syrrhaphus hylaeformis (Cope). Pico Blanco.

Liohyla guentheri (Keferstein). "Costa Rica"; Río Ceibo; Buenos Aires.

- Liohyla bocourti* (Brocchi). Río Sucio.
Liohyla fleischmanni (Boettger). La Palma; San José; Iscazú.
Liohyla pittieri sp. nov. "Costa Rica"; Boruca.
Liohyla engytyppanum sp. nov. Monte Redondo.
Liohyla ranoides (Cope). Buenos Aires; Terraba.
Hylodes polyptychus Cope. La Palma.
Hylodes underwoodi Boulenger. La Palma (1600 m. alt.).
Hylodes platyrhynchus sp. nov. "Costa Rica."
Hylodes cerasinus Cope. La Palma; ? Pico Blanco.
Hylodes euryglossus (Cope). San José.
Hylodes rhodopsis (Cope). Pico Blanco; Buenos Aires; La Palma; Cartago, ?Irazú.
 [*Hylodes rugosus* Peters]. Nicaragua and Panamá.
Hylodes florulentus (Cope). Boruca.
Hylodes melanostictus (Cope). Pico Blanco.
Hylodes brocchii (Boulenger) Brocchi. La Palma (alt. 1600 m.).
Hylodes nubilus sp. nov. Escazú.
Hylodes megacephalus (Cope). Las Delicias; Santa Clara (alt. 500 m.); Pico Blanco.
 [*Hylodes diastema* (Cope)]. Nicaragua and Panamá.
Hylodes gulosus (Cope). Pico Blanco (alt. 6000 ft.).
 [*Engystomops pustulosus* Cope]. Mexico and Panamá.
Bufo haematiticus Cope. Talamanca; Santo Domingo; Golfo Dulce; Las Minas; Río San Juan.
 [*Bufo sternosignatus* Günther]. ?(Costa Rica).
Bufo marinus (Linnaeus). "Costa Rica."
Bufo coccifer Cope. Vicinity San José; Laguna de la Palma.
Bufo coniferus Cope. La Palma; Carillo.
Bufo valliceps Wiegmann. "Costa Rica."
Bufo melanchloris Cope. Eastern Costa Rica.
Bufo leutkenii Boulenger. Cartago.
Bufo auritus Cope. Talamanca.
Nannophryne fastidiosa (Cope). Pico Blanco (alt. 2500 m.).
Nannophryne epiotica (Cope). Pico Blanco.
Nannophryne coeruleascens (Cope). Pico Blanco (alt. 3000 to 5000 ft.).
Hyla cherrii Cope. Alajuela.
Hyla elaeochroa Cope. Sipurio.
Hyla baudini Duméril and Bibron. Cariblanco de Serapiquí; La Hondura.
Hyla venulosa (Laurenti). Bebedero.

Hyla gabbi Cope. Sipurio; La Palma; Monte Rotundo (alt. 1600 m.); Laguna de la Palma; Cartago; San José.

Hyla pseudopuma sp. nov. La Palma (alt. 1600 m.).

?*Hyla godmani* sp. nov. La Palma (also Mexico).

Hyla uranochroa Cope. Río Sucio; La Palma (alt. 1600 m.).

Hyla leucophyllata Beiris. Costa Rica.

Hyla underwoodi Boulenger. Bebedero.

Hyla nigripes Cope. "Costa Rica."

Hyla prosoblepon Boettger. Limón; La Palma.

[*Hyla punctariola* Peters]. ?Costa Rica.

Hyla albomarginata Spix. San Carlos.

Hyllella fleischmanni Boettger. San José; La Palma; Alajuela.

?*Nototrema oviferum* (Weinland). Carrillo.

Agalychnis moreletii (A. Duméril). Cartago and Irazú; Escazú; San José.

[*Agalychnis callidryas*] (Cope). Mexico; Panamá.

Agalychnis helenae Cope. San Carlos.

Agalychnis lemur (Boulenger). "Costa Rica."

In 1920 Emmett Dunn, then a collector for Tom Barbour, and the Museum of Comparative Zoology, began work in Costa Rica, and later made other collecting journeys to that country. Three Costa Rican forms from this first collection are described by Barbour and Dunn (1921): *Syrhophus lutosus* Navarro, Costa Rica, *Phylllobates beatrixiae* Victoria Farm near Zent, and *Eleutherodactylus noblei*, Guápiles, Costa Rica and San Miguel Island, Panamá Bay. Other specimens reported are *Phylllobates talamancae* (Cope), Santa Cecilia; *Eleutherodactylus bransfordi* (Cope), Orotino, Guápiles and Zent; *E. ceresinus* (Cope) (*sic*), Zent; *E. diastemma* (*sic*) (Cope), Monteverde; *E. fleishmanni* (*sic*) (Boettger) Saint Cecilia, Guápiles, La Palma and Cariblanco; *E. lanciformis* (Cope), Navarro and Guápiles; *E. polyptychus* (Cope), Monteverde and Guápiles; *E. rhodopsis* (Cope), Camino del Río; *E. rugosus* (Peters), Monteverde.

In a later paper Barbour (1926) described *Eleutherodactylus persimilis* from a collection made by Dunn and Chester Duryea. Barbour later (1928) described a series of species as follows: *Eleutherodactylus peraltae* and *Hyla lancasteri* from Peralta, Costa Rica. *Syrhophus caryophyllaceus* described from La Loma, Panamá is known to occur in Costa Rica. Several other forms were described from Panamá. In certain of Dunn's papers dealing primarily with the fauna of Panamá, species are reported from Costa Rica also.

Dunn (1931c) reports on some Costa Rican materials, and the following are described as new: *Eleutherodactylus talamancae*, Almirante and La Loma, Panamá; Monteverde, Zent and Suretka, Costa Rica; *Lithodytes gaigei*, Fort Randolph, Barro Colorado Island, Canal Zone; Talamanca Valley, Costa Rica; *Phyllobates flotator*, Barro Colorado Island, Canal Zone; Costa Rica to Darien; *Centrolene valerioi*, La Palma, Costa Rica, 4500 ft. *Hyla colymba* is described from Panamá. Several other species are listed as occurring in Costa Rica. Later (Dunn 1937) described *Hyla picadoi*, a new species, from Volcán Barba and El Gallito, Costa Rica, and certain other species are listed as occurring in bromelias of Costa Rican forests. In 1942 he described *Eleutherodactylus altae* from the pass between Volcán Barba and Volcán Irazú, at approximately 4000 ft. elevation.

In 1934 Otto Wettstein published on Costa Rican materials obtained by R. Zimara and Dr. Otto Koller in a number of Costa Rican localities. The expedition collected 78 herpetological species and subspecies (256 specimens) of which there were three species of salamanders and 17 species and subspecies of frogs and toads. No new species or subspecies are described. The following are listed:

Rana pipiens Schreber. Finca Guayabillos 2200 m. on Volcán Irazú.

Rana warschewitschii O. Schmidt. San Isidro de Coronada 1650 m.; La Carpintera, Volcán Irazú.

Dendrobates auratus Girard. Finca Hamburg am Río Reventazón.

Dendrobates pumilio O. Schmidt. Finca Hamburg, Carillo.

Atelopus varius varius Lichtenstein and von Martens. La Carpintera.

Bufo haematiticus Cope. La Caja near San José.

Bufo valliceps Wiegmann. Bebedero.

Bufo coccifer Cope. San José.

Hyla baudinii Duméril and Bibron. Tilleran, 520 m. San Isidro de Coronada.

Hyla albomarginata Spix. Finca Hamburg.

Centrolene (= *Hyla*) *prosolepon* Boettger. San Isidro de Coronada, Volcán Irazú.

Phyllomedusa (= *Agalychnis*) *callidryas* Cope. Port Limón.

Eleutherodactylus gollmeri Peters. La Carpintera.

Eleutherodactylus melanostictus Cope. Volcán Irazú.

Eleutherodactylus polyptychus Cope. La Carpintera.

Cystignathus (= *Leptodactylus*) *quadrivittatus* Cope. Río Nuevo near Porto Jiménez.

In 1947 Richard Clark Taylor and I made a journey to Costa Rica, remaining there for three summer months. Rather extensive collections of reptiles and amphibians were made in various parts of the country. In 1951 I undertook a second journey, this time spending there a little more than two and a half months. The aggregate of these three collections is approximately 6000 specimens (more than half of which are amphibians) a number possibly equaling all preceding collections.

Two preliminary papers were published. These are: (Taylor 1948) in which are described *Hyla fimbriembra*, Volcán Poás, and *Hyla richardi*, Volcán Poás. In Taylor (1949) four species of Costa Rican frogs are described. These are: *Centrolenella spinosa*, Los Diamantes; *Centrolenella granulosa*, Los Diamantes; *Centrolenella albomaculata*, Los Diamantes and *Centrolenella colymbiphylum*, Volcán Poás.

The material in these collections is treated in this present work and several other species, regarded as new, are herein described.

The new species and subspecies include the following:

Bufo holdridgei, Volcán Barba, 7500 ft. elev.; *Microbatrachylus rearki*, Bataan, Los Diamantes and Turrialba; *Microbatrachylus costaricensis*, Morehouse Finca, near Turrialba; *Eleutherodactylus dubitus*, Isla Bonita, Volcán Poás; *Eleutherodactylus crassidigitus*, Isla Bonita, Volcán Poás; *Hyla alvaradoi*, Moravia; *Hyla rivularis*, Isla Bonita, Volcán Poás; *Hyla immensa*, Turrialba; *Hyla rufiocula*, Isla Bonita, Volcán Poás; (also Morehouse Finca near Turrialba and Moravia); *Hyla alleei*, Isla Bonita, Volcán Poás; *Hyla debilis*, Isla Bonita, Volcán Poás; *Hyla wellmanorum*, Bataan, *Hyla angustilineata* La Palma; *Hyla moraviaensis*, Moravia; *Cochranella talamancae*, Moravia; *Atelopus senex*, *Atelopus varius loomisi*, *Atelopus varius ambulatorius*, Volcán Poás.

Bufo gabbi, a new name, is given for *Bufo auritus* Cope (*nec. Bufo auritus* Raddi).

CLASSIFICATION

DISTRIBUTION OF SUBORDERS AND FAMILIES OF SALIENTIA IN THE WESTERN HEMISPHERE

Amphicoela	Liopelmidae. Northwestern United States.
Opisthocoela	{ Rhinophrynidæ. Mexico. Pipidae. South America.
Anomocoela	Pelobatidae. North America to southern Mexico.
Procoela	{ Bufonidae. North, Central and South America. Brachycephalidae. Central and South America. Leptodactylidae. Mexico, Central and South America. Centrolenidae. Mexico, Central and South America. Hylidae. North, Central and South America.
Diplasiocoela	{ Microhylidae. North, Central and South America. Ranidae. North and Central America (barely entering South America).

DISTRIBUTION OF COSTA RICAN GENERA OF SALIENTIA IN THE WESTERN HEMISPHERE

	United States	Mexico	Guatemala	Costa Rica	Panamá	South America
Bufo	X	X	X	X	X	X
Atelopus				X	X	X
Phyllobates				X	X	X
Dendrobates				X	X	X
Eleutherodactylus	X	X	X	X	X	X
Leptodactylus	X	X	X	X	X	X
Eupemphix		X	X	X	X	X
Microbatrachylus		X	X	X	X	?
Centrolene				X	X	X
Cochranella		X	X	X	X	X
Teratohyla				X	?	?
Hyla	X	X	X	X	X	X
Anotheca		X	?	X		
Acrodytes		X	X	X	X	X
Smilisca	X	X	X	X	X	X
Agalychnis		X	X	X	X	X
Phyllomedusa				X	?	X
Hypopachus	X	X	X	X	?	X
Microhyla	X	X	X	X	X	X
Rana	X	X	X	X	X	X

At least three South American salientian genera reach Panamá, which may or may not be found eventually in Costa Rica. These are *Prostherapis*, *Hemiphractus*, and *Elachistocleis*.

FAMILY BUFONIDAE

Bufonidae Hogg, Ann. Mag. Nat. Hist., ser. 2, vol. 7, 1841, p. 361.

This family comprises groups of amphibians commonly designated toads, but this common term is likewise often applied to

amphibians of other families whose bodies are squat and whose movements are slow. In Spanish-speaking countries the members of the family are usually called *sapo*.

In the groups of the Family Bufonidae represented in the Costa Rican fauna, here recognized under the genus *Bufo*, certain of the species, having a relatively wide distribution, are well known; while several others still are known from the types only, or at least from very few specimens. In the former group are *Bufo haematiticus* Cope, *Bufo marinus* Linnaeus, *Bufo coccifer* Cope, and *Bufo coniferus* Cope. In the latter are *Bufo fastidiosus* Cope, *Bufo gabbi* *nov. nom.* (for *Bufo auritus* preoccupied), *Bufo leutkenii* Boulenger, *Bufo epioticus* Cope, *Bufo melanochloris* Cope, *Bufo coerulescens* Cope, and *Bufo holdridgei* *sp. nov.*

Certain other species occur in neighboring areas north and south of Costa Rica and some of these very probably will eventually be found within the borders of Costa Rica. In this group may be listed *Bufo politus* Cope, from Nicaragua; *Bufo simus* Schmidt, ?*Bufo granulatus* Spix, *Bufo typhonius* (Linnaeus), and *Bufo veraguensis* Schmidt from Panamá.

The species represent diverse groups, certain of which have been placed—perhaps correctly—in genera other than *Bufo*. However the effect of Boulenger's treatment of these genera in his "Catalogue of the Batrachia Salentia" has been so far-reaching that many of these genera are now not recognized because they were synonymized with *Bufo*.

The following generic names have been proposed by Cope and others:

<i>Rhacbo</i> Cope	<i>Bufo haematiticus</i>
<i>Bufo</i> Laurenti	<i>Bufo politus</i>
<i>Phrynoidis</i> Fitzinger	<i>Bufo marinus</i>
<i>Otiophis</i> Cope	<i>Bufo typhonius</i>
<i>Cranophryne</i> Cope	{ <i>Bufo fastidiosus</i> <i>Bufo simus</i>
<i>Crepidophryne</i> Cope	<i>Bufo epioticus</i>
<i>Ollotis</i> Cope	<i>Bufo coerulescens</i>
	{ <i>Bufo veraguensis</i> <i>Bufo granulatus</i> <i>Bufo coccifer</i>
<i>Incilius</i> Cope	{ <i>Bufo coniferus</i> <i>Bufo leutkenii</i> <i>Bufo melanochloris</i> <i>Bufo gabbi</i>

The seeming rarity of so many species of toads is perhaps purely a matter of lack of collecting at the proper time. If the collector chances to come upon a population during the breeding period the species may be seemingly "common"; at almost any other season of the year few or no individuals may be encountered and it is "rare." In the case of the toads originating on Pico Blanco, Costa Rica, their apparent rarity is, first of all, due to the fact that the type locality has not been revisited. There is a probability that the fauna is of very limited distribution; otherwise one might expect certain of the rare species to appear in collections obtained elsewhere in Costa Rica and Panamá.

References appear in literature to certain other species as occurring in Costa Rica.

Bufo valliceps Cope. A specimen of *Bufo* was referred to this species by Cope (1875). Later he based a new species, *Bufo melanochloris*, on the same specimen.

Otto Wettstein (1934) has again listed *Bufo valliceps* from Costa Rica (Bebedero); but it is possible that this record represents an error of identification since he comments that perhaps *Bufo canaliferus*, *Bufo marmoratus*, *Bufo coccifer*, and *Bufo valliceps* will be found to be races of the same species! I regard this suggestion as highly improbable since two or three of these forms are found together in certain areas where they occur. *Bufo marmoratus* occurs in Mexican territory with *valliceps* and *coccifer*; and *canaliferus* occurs with *valliceps* and *coccifer*. It is not impossible that all four occur together in the Tehuantepec area.

Bufo sternosignatus is listed by Keferstein (1868) from Costa Rica, in a report on a collection made by Prof. K. von Seebach in 1865. This reference has been placed by Boulenger (1882) with *sternosignatus* Günther. However, some of Günther's *sternosignatus* were confused with *valliceps* and part of Günther's syntypes are referred to *valliceps* by Boulenger. Keferstein may have had Cope's *melanochloris*, which Cope himself, at first, regarded as *valliceps*. A form of *valliceps* actually may occur, or *sternosignatus* may occur. Keferstein distinctly states that the characteristic marking, from which the name is derived, a cross on the breast, is in evidence in his specimen called *sternosignatus*. In view of the uncertainty of this identification, I am considering *sternosignatus* as a doubtful member of the fauna until it is rediscovered.

Genus BUFO Laurenti

Bufo Laurenti, Specimen medicum, exhibens Synopsin Reptilium . . . ,
Viennae, 1768, p. 25 (type of genus *Bufo vulgaris*).

Eleven species are recognized as occurring in Costa Rica.

KEY TO THE COSTA RICAN SPECIES OF BUFO

1. Head lacking the typical series of cranial crests 2
 Head with a series of elevated cranial crests 4
2. Larger (to 75 mm.); tympanum present, its diameter half length
 of eye; ostia pharyngea (openings of eustachian tubes) pres-
 ent; parotoid glands elongate, angulate; body dorsolaterally
 angulate; toes scarcely webbed; skin soft or slightly rough,
 with only minute tubercles; widespread in central Costa
 Rica *haematiticus*
 Smaller (under 40 mm.); tympanum absent; no ostia pha-
 ryngea; no vocal sacs or slits 3
3. Feet almost completely webbed, the fourth toe extending beyond
 web; inner digits of both hand and foot rudimental; 35 mm.;
 Pico Blanco, C. R., 5000 ft. elev. *epioticus*
 All digits without web; inner digits not rudimental; 25 mm.;
 Pico Blanco, C. R., between 2000 to 5000 ft. elev. *coerulescens*
4. Tympanum present 5
 Tympanum absent 6
5. Tympanic area covered by a bony rugose plate; ostia pharyngea
 absent; no vocal sac or vocal slits in males; no discrete dorso-
 lateral stripes; a black throat spot; Pico Blanco, C. R., (Dis-
 trict of Uren) 2500 ft. elev. *fastidiosus*
 Tympanum area not covered by a lateral bony plate; ostia
 pharyngea, vocal sac and vocal slits absent; a discrete dorso-
 lateral stripe; no black throat spot; 7000 ft., Volcán Poás,
 C. R. *holdridgei*
6. Diminutive species (31 mm.) lacking a preorbital crest; parotoid
 surmounted by dermal spines; heel to snout tip; toes half
 webbed, auricular region with a strongly projecting shelf; only
 anterior part of tympanum visible; "East coast region," Costa
 Rica *gabbi*
 Larger species (above 50 mm.); preorbital crest present; paro-
 toids not surmounted by dermal spines; heel does not reach
 eye; no strongly projecting shelf, or if present reduced and
 heel reaching only to eye 7
7. Large toads reaching 200 mm. in length; parotoid very large,
 broadly triangular in shape, its diagonal length equal to or
 greater than length of head; heel to middle of parotoid.
 Widespread *marinus*
 Smaller toads (probably less than 100 mm.); parotoids smaller,
 less than area of the supraocular cover 8
8. Heel fails to reach the parotoid; tympanum diameter in eye length
 approximately 2.2 times; parotoid oval, rounded or biscuit-

- shaped, diagonally placed; equal to or slightly longer than the supraocular cover; head crests rather low; 70 mm.; San José, "Arriba," Cartago, Costa Rica *coccifer*
- Heel reaches to tympanum or eye; parotoid distinctly smaller and shorter than supraocular cover; head crest more elevated; tympanum one half of eye 9
9. A dorsolateral row of large sharp conical tubercles (10-12) from parotoid to near groin; toes half webbed; a flat surface between nostrils; sides of neck, legs and arms with strong conical spines; large (100 mm.); widespread; El General, C. R.; Central America to Ecuador *coniferus*
- Dorsolateral spiny tubercles not strongly pronounced 10
10. Toes nearly free; eastern central Costa Rica *melanochloris*
- Toes half webbed; Cartago, C. R. *leutkenii*

Bufo haematiticus Cope

Figure 1

- Bufo haematiticus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, pp. 157-158 (type locality "Region of the Truando, New Granada"); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 101 (Sipurio, Costa Rica) and p. 155 ("Camp Mary Caretta, Panamá"); Günther, Proc. Zool. Soc. London, 1870, p. 401; Peters, Monatsb. Akad. Wiss. Berlin, 1873, p. 618 (Chiriquí, Panamá); Boulenger, Catalogue of the Batrachia Salientia s Ecaudata in the collection of the British Museum, 2nd ed. 1882, p. 290 (Costa Rica); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 10 (Talamanca, Costa Rica; "Mary Caretta" [possibly Margarita] Panamá; Coban, Verapaz, Guatemala; Nicaragua); Günther, Biología Centrali-Americana; Reptilia and Batrachia, Feb. 1901, pp. 243-244 (localities in Nicaragua); Nieden, Das Tierreich, Lief. 46, Anura, 1, 1923, pp. 110-111 (Nicaragua to Colombia); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, p. 408 (Canal Zone); Wettstein, Sitzungsab. Akad. Wiss. Wien, Math-Naturw. Kl., Abb. 1. Bd. 143, Heft. 1 and 2, 1934, p. 7.
- Rhaebo haematiticus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, pp. 357-358; *idem, ibid.* 1863, p. 49.
- Rhaebo haematiticus* var. *lachrymans* Cope, *ibid.* 183, p. 358 (same type locality as *haematiticus*).
- Bufo (Rhaebo) haematiticus* Keferstein, Nachr. Ges. Göttingen, 1867, pp. 353-354, pl. 9, fig. 3, (Costa Rica).

Diagnosis: Crown of head lacking elevated crests except for a short thick ridge above tympanum; parotoids elongate, with an angular edge continuous with the supratympanic ridge anteriorly and posteriorly with a skinfold that continues diagonally to near the groin; undersurface of hands and feet smooth with small terminal enlargements; first finger longer than second; web small between toes; back with small tubercles; skin of ventral surfaces without tubercles. Tympanum distinct. Eustachian tubes with openings.

Description of species: K.U.M.N.H. No. 24767 ♀. Head width at tympanum (22 mm.) a little greater than its length (21 mm.); canthus rostralis with angular edge; nostrils lateral, area about them slightly swollen; loreal region subvertical, slightly concave; canthal

ridge continuous with the ridge on eyelid; supraorbital edge elevated, the area between, concave; distance between the summit of the elevations (9 mm.) much greater than width of eyelid; tympanum distinct, irregularly oval (5 mm. high x 3.4 mm. long); length of eye (8 mm.) and length of snout (8 mm.) equal; parotoid large, its greatest length 15-16 mm., its dorsal width 6 mm., its greatest lateral elevation 5 mm.; lateral edge of parotoid sharp, continuous



FIG. 1. *Bufo haematiticus* Cope. K.U.M.N.H. No. 24762; Turrialba, Costa Rica; actual snout-to-vent length, 68 mm.

with a skin fold that reaches to near groin; no vomerine teeth; choanae equally (or nearly) as large as openings of the Eustachian tubes, oval in shape and somewhat lateral in position; tongue elongate, narrowed anteriorly and posteriorly, not or but slightly emarginate posteriorly; (male with a vocal sac, the single vocal slit sinistral and rather far back in mouth); palate strongly corrugated posteriorly.

Arm long; fingers elongate, the first longer than second and likewise larger and equally as long as third; large subarticular tubercles; supernumerary tubercles on palm present but indistinct; outer palmar pad large, circular, inner large, prominent at base of first finger; (no sexual modification of the first finger discernible in male); arm, drawn backward, fails to reach end of body (in male extends a little beyond body); a row of indistinct tubercles under forearm; small pads under terminal phalanges very slightly wider than adjoining part of digit; legs moderately long, the toes short, with thickened terminal pads slightly wider than adjoining part of digits; a strong inner metatarsal tubercle, and a small rounded outer tubercle; subarticular tubercles distinct, but little elevated; a web remnant between toes with a lateral ridge or fringe on digits extending to terminal pad; no tubercles on sole; a tarsal fold extending half length of tarsus; heel reaches to middle of orbit; when femora are placed at right angles to body the heels barely touch.

Skin tubercular on dorsal surfaces, nearly without tubercles on under surfaces; granular about vent and under mesial portions of femora; slightly granular on posterior part of abdomen.

Color: Brownish or blackish brown on dorsum with a few light tan flecks on shoulders, rather more grayish on sides; venter dusky, more or less clouded or flecked with darker; underside of femur mottled dark and light; underside of feet and hands slate; under surface of tibia blackish with distinct purple spots on anterior and posterior faces; purple spots on foot and on anterior face of femur; side of head, neck and body with a purplish stripe, bordered above by the diagonal lateral skin fold of light lavender.

Measurements in mm.: Nos. 24767 ♀ and 24761 ♂; snout to vent, 73, 54; length of snout, 8, 6; length of eye, 8, 6.1; height of tympanum, 5, 3.4; length of tympanum, 3.4, 2.2; length of parotoid, 15-16. 15; arm, 44.6, 34; hand, 17, 13; leg, from vent, 95, 74; tibia, 30, 25; foot and tarsus, 38, 33.

Variation: In some of the specimens there is marked difference in coloration, some being nearly uniform black while others are light purplish above with paired discrete black spots or scattered small spots and flecks. Some are uniform light brown above. Certain other specimens are blackish or brownish above with yellowish tan or reddish marks distributed as follows: a diagonally-placed pair of spots between orbits; a transverse pair just behind orbits narrowly separated; a pair of regular spots on shoulder, a single median spot on middle of back; a pair on the rump and two small irregular spots

behind these; a small black-edged cream spot on lores in front of, and partially below, eye.

The recently transformed young were present in the bed of the Río Reventazón in considerable numbers, where tiny pools of water were to be found in rough masses of rock, some feet above the present level of the river water. It was presumed that the eggs had developed there.

Specimens were taken in the town of Turrialba and on the farm of the Inter-American Institute of Agriculture near Turrialba; at Los Diamantes, and Río Segundo, localities representing drainage both to the Caribbean Sea and the Pacific Ocean.

Bufo marinus marinus (Linnaeus)

Rana marinus Linnaeus, Systema Naturae, 1758, ed. 10, p. 211 (From Seba, Thesaurus, 1734).

Bufo marinus Schneider, Historiae amphibiarum naturalis et literariae, 1799, fasc. 1, pp. 219-222; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 138-139 (good bibliography).

Bufo aqua Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 101 (Eastern Coast of Costa Rica; "especially abundant about houses"). (The very extensive synonymy of this widespread form is not here included. Nieden, *loc. cit.*, has the most complete listing of the other literature.)

Diagnosis: Enormous toads having a broad triangular-shaped body, with very large somewhat triangular parotoid glands reaching low on sides of head; head bearing all parts of the cranial crests, the parietal, perhaps, being least developed; parotoids usually reddish or russet brown in color; metatarsal tubercles very small proportionally; first finger longer than second. Males usually more rugose and smaller than females.

Description of species: (K.U.M.N.H. No. 28245, Turrialba). Head broader than long, of somewhat triangular shape; canthal crests begin close to each other between nostrils and are continuous with the curving supraocular crests, but slightly angulate at a point in front of orbit where the preorbital crest branches and continues down and slightly backward to a point below orbit; supra-orbital crest curves behind eye to edge of head where it is in contact with a short supratympanic crest, and continues down behind eye as a postorbital; a pair of low parietal crests are given off from the supraorbitals; below eye there is indication of a suborbital crest (or a continuous row of tubercles) from end of preorbital crest back to below tympanum; length of eye orbit (17 mm. measured inside crests) much greater than snout length (13 mm.); nostrils closer to eye than to median anterior point on lip; tympanum small, nearly a third higher than long, its greatest diameter (7 mm.) slightly less

than half length of orbit; choanae moderate, transversely oval; tongue longer than wide, free for more than one third of its length, narrowly free on both sides; (males with paired vocal slits).

Skin of head everywhere ossified; parotoids enormous, swollen, the greatest (diagonal) length 45 mm.; greatest width 32 mm.; parotoid in contact with tympanum and supratympanic crest, and separated from its fellow by a distance of 27 mm.; interorbital region somewhat rugose; skin generally smooth with larger and smaller warts and tubercles, of which two somewhat irregular series are found on each side of the median line.

Arms and legs bearing warts and tubercles, the summits of which are covered with horn; venter and chin more or less covered with small, nearly uniform, granular tubercles, smaller and less distinct under thighs; concealed surfaces of limbs nearly smooth; upper eyelids with small warts.

Arm short, the first finger distinctly longer than the second; a small inner metacarpal tubercle at base of the first finger, a large rounded outer (median) palmar tubercle; subarticular tubercles single, small, horny; palm covered with small tubercles; leg short, the heel reaching only to middle of parotoid; a distinct, horny, tarsal fold half length of tarsus; toes about half webbed, the subarticular tubercles small, while sole and tarsus covered with smaller tubercles; inner metatarsal tubercle small, oval, outer nearly as large, but less elevated; several segregated tubercles between the two, make an indistinct horny pad.

Color: Generally reddish brown on dorsum, gradually changing to grayish brown and gray posteriorly and on hind limbs; parotoids nearly red with black on their anterior dorsal surface; some indefinite blackish brown spotting on area between parotoids; below dirty cream mottled or clouded with dusky.

Measurements in mm.: Snout to vent, 143; width of head, 52; length of head, 38; height of head (to top of crest), 24; arm, 75; hand, 31; leg, 155; tibia, 52; foot and tarsus, 81.

Variation: Males are somewhat more rugose with a smoother venter, somewhat smaller parotoids, and somewhat stronger parietal crests. Each wart and tubercle of the dorsal surface has numerous horny spinules, giving the dorsum an extremely roughened surface, the larger tubercles bearing 8 to 10 spinules. Young specimens have low crests but usually can be distinguished from other toads by the large parotoids. The call is a low-pitched, sustained trill, and is suggestive of a trilled low note of a marimba.

The species probably occurs everywhere throughout the lowland areas. It was common at Turrialba, and many large specimens were seen in the town. It is somewhat domestic and is encountered most frequently in areas about human habitations. At Cartago it was found less frequently. The most surprising locality where it was found was a small open meadow pond at an elevation of nearly 7000 feet on Volcán Poás (western slope). The specimen is a very large female.

Rana pipiens and *Rana vibicaria* were also taken in the same pond.

Specimens were also taken at Bataan (eastern lowlands), at Moravia; and heard, but not taken, at Los Diamantes near Guápiles. They appeared to be equally common throughout the summer. One large breeding chorus was encountered at Bataan on July 22, 1951.

Bufo fastidiosus (Cope)

Cranopsis fastidiosus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 96-97, pl. 23, fig. 1 (type locality, 2500 ft. elevation on slope of Pico Blanco, district of Uren, C. R., Wm. Gabb, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 11 ("district of Talamanca").

Bufo fastidiosus Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 326; Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, pp. 83-84 (data from Cope); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 135-136.

Nannophryne fastidiosa Günther, Biologia Centrali-Americana; Reptilia and Batrachia, May 1901, p. 257 (data from Cope).

This toad was not found in our Costa Rican collecting. I have examined, however, the two specimens in the U. S. National Museum (Nos. 32584 and 32587 from Costa Rica).

Diagnosis: A medium-sized toad, snout to vent, 58 mm. Skin of head entirely co-ossified with cranial bones; head crests strong, the supratympanic crest obtusely thickened, extending to the parotoid gland, and produced downward behind orbit as a rugose bony plate in the tympanic area; no tarsal fold or tubercles; no openings to Eustachian tubes; no tympanum; no vocal sac or slits.

Description of species: (From a cotype). Head wide, not depressed: cranial ridges including an elevated canthal ridge, a supra-orbital, a postorbital and a supratympanic crest, extending back to parotoid gland; supratympanic crest thickened and produced downward behind orbit as a rugose plate to a point opposite inferior border of eye pupil; a rough concave margin bounding area usually occupied by tympanum; canthal ridges short with a groove between them; loreal and labial regions rugose with small tubercles. In profile, muzzle descends abruptly to lip and the snout tip does

not overhang the lip; posterior outline of cranial ossification squarely truncate in adults.

Parotoids short subtriangular, sublateral, as deep as long; upper surfaces on limbs and body studded with round warts, so closely approximated on limbs as to "resemble a pustular disease"; row of larger tubercles from parotoid to axilla; below numerous smaller tubercles; fingers short, free; palmar tubercles very obtuse; no tarsal folds or tubercles; tubercles on soles obscure; toes half webbed; end of longest toe reaches muzzle when extended; longest finger reaches vent.

Color: Yellowish brown above, dirty brown below; a black band extends from parotoid to axilla, or may be extended on side of abdomen, the color not affecting the light color of the tips of spines and tubercles; throat with a black spot; top of head yellow or brownish yellow.

Measurements in mm.: Snout to vent, 58; snout to orbit, 5; snout to posterior part of cranium (head length), 16; arm, 35; hand, 13; leg, 60; foot, 35.

Remarks: The tubercles on the back are not arranged in a median paired series; the lateral series of tubercles tend to diminish posteriorly. The anal flap is elongated tending to form a tube, opening at lower level of thigh, while behind the opening two ridges are indicated, separated by a groove. There are nuptial spines on two fingers in the male. The venter and chin are regularly granular, while under the thighs the granules are unequally distributed. The parotoids abut on the supratympanic ridge. The tongue is free for most of its length. Vocal sacs are wanting in males, perhaps concomitant with the loss of the tympanum.

I believe the species has not been rediscovered since the types were taken. Since the elevation of the type locality is relatively low (2500 ft. on Pico Blanco), one might expect the distribution to be extensive and not limited by the mountain Pico Blanco. The relationship of this form is with *Bufo bocourti* and *Bufo simus*.

Bufo epioticus (Cope)

Figure 2

Crepidius epioticus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), pp. 97-98, pl. 23, fig. 2 (type locality, 5000 ft. elevation, Pico Blanco, Costa Rica); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 95; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 11 (Salamanca, [= ? Talamanca Mountain Range] Costa Rica).

Bufo epioticus Boulenger, Catalogue of the Batrachia Saliientia s. Ecaudata in the collection of the British Museum, 2nd ed., pp. 326-327; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 135.

Nannophryne epiotica Günther, Biologia Centrali-Americana; Reptilia and Batrachia, May 1901, p. 257.

Diagnosis: A small toad (35 mm.) lacking a tympanum, and lacking openings into the Eustachian tube (ostia pharyngea); a parotoid gland present; digits of feet webbed leaving longest median toe projecting; skin on head not ossified; inner digit of both feet rudimental. Tympanum absent.

Description of species: (From Cope.) Head a little narrower than body; cranial crests consisting of a canthal and supraorbital crest, forming a straight line from nostrils to supratympanic region, thickened opposite front of orbit, and a distinct supratympanic crest; superciliary ridges send inward; a short tuberosity at the



FIG. 2. *Bufo epioticus* (Cope). Copied from Cope, Jour. Acad. Nat. Sci. Philadelphia, 2nd ser., vol. 8, pl. 23, fig. 2 (*Crepidius epioticus*); 5000 ft. elev. Pico Blanco, Costa Rica; head-body length, 35 mm.

posterior third of orbit. Supratympanic crest short, very protuberant giving the cranium an angular outline; a low narrow postorbital ridge; no trace of tympanum; parietal region with several small osseous nodules on each side; parotoid very small, subcircular; skin everywhere rugose with minute tubercles which are sparse on dorsal, dense on ventral regions; soles smooth, no tarsal, carpal or solar tubercles or folds; longest digit extends for the length of 2.5 phalanges beyond the "flat mass" which includes the other digits; femur half enclosed in inguinal integument; a concave dermal fold from end of each sacral diapophyses to parotoid gland, which is easily obscured.

Color: Generally black; dorsum a little lighter with a few darker spots on each side; soles and palm yellowish; scapular region brown; sometimes a median dorsal band.

Measurements in mm.: Snout to vent, 35; length to orbit, 4; length to jaw angle, 11; length to axilla, 17; length to groin, 30; arm, 19; hand, 7; leg (free portion), 30; hind foot, 18.

Remarks: This species is from an elevation of 5000 ft. on Pico Blanco. One may presume that its distribution is limited to the Talamanca Range.

I was unable to find the type of *Bufo epioticus* at the U. S. National Museum and suspect that it is lost. To my knowledge the species has not been rediscovered, and is still known only from the type specimen.

Bufo coerulescens (Cope)

Ollotis coerulescens Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 98-99, pl. 23, fig. 3, 3a (type locality 3000 to 5000 ft. on Pico Blanco, Costa Rica, Wm. Gabb, coll.); Boulenger, Catalogue of the Batrachia Saliencia s. Ecaudata in the British Museum, 2nd ed., 1882, p. 281.

Bufo caerulescens Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 83 (data from Cope); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 135 (data from Cope).

Nannophryne coerulescens Günther, Biologia Centrali-Americana; Reptilia and Batrachia, May 1901, pp. 257-259 (data from Cope.)

Diagnosis: Very small toads, 25 mm. snout to vent; most cranial ridges and tympanum absent, and there are no openings to the Eustachian tubes; skin of top of head not co-ossified with the skull bones; all digits without webs; blackish, with brown tubercles on upper surfaces; below, black, thickly marked by light blue spots.

Description of species: (The following data are from the type description.) No prominent cranial ridges except a protuberant supratympanic; the supraciliary ridge slightly elevated, continued behind in straight lines by two angles of parietal bone; no trace of a tympanum; canthus rostralis straight, angular, the lores elevated; nostrils nearer to each other than each is to orbit; tongue large elongate; skin of back and sides studded with numerous spaced tubercles, the lower surfaces nearly smooth; no tarsal fold; tubercles of palm and sole obsolete; digits distinct, those of the foot half webbed. The wrist of arm, and end of second toe of hind limb when extended forward, reach end of muzzle.

Color: Upper surfaces blackish, the tubercles brown; below black, thickly marked with light blue spots.

Measurements in mm.: Snout to vent, 25; width of head, 8; snout to orbit, 3; snout to axilla, 10; snout to groin, 21; arm, 14; hand, 5; leg, 23; foot, 13.

Remarks: This small species, approximately one inch long, may or may not be an adult animal. The type description was taken from

the largest of the cotypes and Cope comments that there is no evidence of immaturity. The specimens were taken between 3000 and 5000 ft. on Pico Blanco. This species has not been found again since the types were collected.

Bufo holdridgei sp. nov.

Figure 3

Type: K.U.M.N.H. No. 30885, collected at an elevation of approximately 7500 ft. on Volcán Barba, western slope, July 15, 1951, by Edward H. Taylor.

Diagnosis: A small toad with very short hind legs, the heel reaching to shoulder; fingers with a web remnant (about $\frac{1}{3}$ webbed); first finger longer than second; cranial ridges except supratympanic



FIG. 3. *Bufo holdridgei* sp. nov. Type. K.U.M.N.H. No. 30885; 7500 ft. Volcán Barba, western slope, Costa Rica; actual snout-to-vent length, 28 mm.

indistinct or obsolete; canthus marked, nostril nearer eye than median point on upper lip; a few conical or papillate tubercles on back and sides; no vocal sacs, no ostia pharyngea (openings of the Eustachian tubes); black above with a discrete cream line from parotoid to groin and an indication of a median, discontinuous, lighter line; venter marbled black and flesh-white; venter with rounded granules; anal opening at ventral level of thighs.

Description of type: A small specimen (28 mm.) perhaps young; the skin more or less co-ossified with skull bones; head rather flat, sloping down slightly from occiput with a slight but distinct depression between the somewhat angular canthi; areas about nostrils swollen; a vertical median ridge runs down abruptly to the median notch in upper lip, becoming slightly bifid, projecting slightly beyond lower lip; loreal region high, not or scarcely concave, sloping abruptly to lip; eye large, its length (3.5 mm.) a little greater than median snout length; a slight indication of a supraocular ridge curving about orbit with an indication of a parietal branch; a rather wide bony supraorbital ridge joining posteriorly with the small parotoid, the limit of ridge and gland indistinguishable where they join; a distinct postorbital ridge which has a short branch curving posteriorly at lower eye level; tympanum absent; parotoid on right side approximately 2 mm. long, and 2.5 mm. wide (2.8 mm. x 2.5 mm. on left side); width of an eyelid, 2.5 mm.; narrowest inter-orbital width, 3 mm.

Palate high, the choanae small, the greatest length of one in distance between them three times; openings of palatal glands two, situated between middle of choanae; no vomerine teeth; tongue elongate, free for half its length; no vocal slits (sex ?); no ostia pharyngea.

Arms relatively long; half or nearly half of forearm reaches beyond the tip of snout; when limbs are adpressed elbow and knee fail to touch; toes one-fifth or less webbed; first finger longer than second but shorter than third; inner metacarpal tubercle present and a large single palmar tubercle; subarticular tubercles flat, somewhat indistinct as are the supernumerary tubercles on palm; longest finger reaches beyond vent.

Leg relatively short, the heel reaching the shoulder; toes approximately one-third webbed; subarticular tubercles and supernumerary tubercles flat, indistinct; inner metatarsal tubercle distinct, outer smaller, but distinct, somewhat elevated (right leg amputated just below knee); no inner or outer tarsal folds or rows of tarsal tubercles.

Skin with papillate pustules scattered on back and sides; between larger pustules are smaller tubercles, and still finer minute granules or spines (evident under lens as a minute black peppering over white dorsolateral line); a rather prominent mental gland; vent carried to lower level of thigh, somewhat elevated about opening; skin of venter somewhat granular; arms and legs with rough tubercles.

Color: Generally black or blackish brown above with discrete dorsolateral white lines from supratympanic crests to groin; a discontinuous median line not especially distinct; black of sides extending to level of venter; venter white; marbled with brownish black; under side of limbs similarly colored; chin largely white; hands and feet barred with dark and light.

Measurements in mm.: Snout to vent, 28; width of head, 11.6; length of head, 10; length of eye, 3.5; length of snout, 3.35; elevation of head at parotoid, 6; arm, 19.8; leg, 34; tibia, 9; foot and tarsus, 16.2.

Remarks: It is presumed that this species is related to *Bufo fastidiosus* since both seemingly lack the ostia pharyngea and the tympanum throughout life. From *fastidiosus* it differs in that the bony process covering the tympanic area is absent, and the dorsolateral white stripes are present. Ventral and dorsal coloration is different. Crests are probably never developed as in *fastidiosus*. There is no distinct row of tubercles from tympanic area to groin; toes are less than half webbed; top of head black, not yellow. The numerous large warts and tubercles on the sides are absent.

While it is not easy to make a comparison of two specimens differing so much in size as this and the types of *fastidiosus*, I have no doubt as to the distinctness of the form here described.

The species is dedicated to my good friend, Dr. Leslie Holdridge of the Costa Rican Ministry of Agriculture, my host at Río Segundo, who provided transportation for me to the collecting grounds on Poás and Barba volcanoes and collected numerous specimens which he presented to me.

Bufo coccifer Cope

Bufo coccifer Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 130 ("Arriba," Costa Rica, C. N. Riotte, coll., U.S.N.M. No. 6490); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 100-101, pl. 23, fig. 5 (the text in this description is the same as that for the preceding reference, save that the locality is omitted); U. S. Nat. Mus. Bull. No. 32, 1887, p. 11 ("Tuchitan" = Juchitán, Tehuantepec, F. Sumichrast, coll.; city of Guatemala, Van Patten, coll.); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd Ed., 1882, p. 322 (Costa

Rica); Günther, *Biologia Centrali-Americana*, Reptilia and Batrachia, Feb. 1901, pp. 250-251 (Tehuantepec, Mexico; Guatemala City, Guatemala; vicinity of San José, Laguna de Palma, Costa Rica, Underwood, coll.); Nieden, *Das Tierreich*, Lief. 46, Anura I, 1923 June, pp. 76, 132 (Mexico to Costa Rica); Kellogg, *U. S. Nat. Mus. Bull.* 160, 1932, pp. 35, 41, fig. 6, a, b; Wettstein, *Sitzungsb. Akad. Wiss. Wien, Math.-Naturw. Kl. Abt. 1*, Bd. 143, Heft 1 and 2, 1934, p. 7 (San José, Costa Rica); Taylor and Smith, *Proc. U. S. Nat. Mus.*, vol. 95, 1945, p. 558, pl. 22 (Agua del Obispo, Guerrero, Mexico); Smith and Taylor, *U. S. Nat. Mus. Bull.* 194, 1948, p. 44 (Cacoprieto, Oaxaca, and other recorded localities).

Diagnosis: A medium-sized toad, snout-to-vent measurement 70 mm.; head with a complete set of rather high cranial ridges; a small parietal branch also present; a subocular ridge present; parotoids distinct, small, diagonal, somewhat circular or globular, touching the supratympanic crest; tympanum distinct; no tarsal fold, but an indistinct row of tubercles; heel to parotoid gland; first and second fingers equal; toes about half webbed.

Description of species: (K.U.M.N.H. No. 24747) Canthal crests begin above nostrils, they join the supraocular ridges at an obtuse angle; latter crests curve above eye where they branch to form a thick supratympanic crest; a short slender postocular crest sharply defined; a short but distinct parietal crest; head wide (28 mm.), considerably greater than its length (21 mm.); snout rather pointed, the canthal crests separated anteriorly by only a very narrow depression; a slight vertical ridge on the tip of the snout; eyelid, with a thick edge, its width 5.4 mm., equals width between the supra-orbital ridges (5.4 mm.); area about nostril swollen, the loreal region sloping abruptly; length of eye (7 mm.) a little less than length of snout (7.5 mm.); the suborbital ridge begins at posterior edge of upper jaw, and nearly parallels it to anterior level of eye; tympanum small, its greatest diameter (vertical, 3.2 mm.) contained in eye length, 2.18 times; parotoid length, 8 mm., width, 5.8 mm., diagonally placed, in contact with tympanum and supratympanic ridge.

Choanae small; tongue elongate, the sides nearly parallel, free for more than half of its length; (males with vocal slits). Arms moderately large, the wrist reaching beyond snout; fingers free; first finger equal to, or, a little longer than second; none of the sub-articular tubercles bifid; digits not tipped with horn; two large palmar tubercles.

Leg short, the heel fails to reach to parotoid; foot one fourth webbed; inner metatarsal tubercles large somewhat pointed anteriorly the outer tubercle smaller; distal subarticular tubercles of third and fourth toes bifid.

Skin of dorsal surface everywhere tubercular or slightly spinous, especially on sides of neck and body; all ventral surfaces finely granular.

Measurements in mm.: Snout to vent, 70; head width, 28; head length, 21; arm, 37; hand, 9; leg, 69; tibia, 24; tarsus and foot, 34.

Color: Above brownish black with a very indistinct lighter stripe from parotoid to groin, bordered below by a dark stripe; some dark dorsal reticulation; ventral surface dirty yellowish-white; distinct reticulation on posterior face of thighs; a very indistinct narrow median light line.

Remarks: Males are generally olive above, and all have a greenish black spot on the throat over the vocal sacs; many tubercles on feet lighter than ground color. One or two specimens have some dark spotting on breast. There is considerable variation in vocal slits. Some males have them dextral, some sinistral, some have them present on both sides. Males have the nuptial asperities present, chiefly on the first and second fingers; a small row is also present on the inner edge of the third.

All of the specimens of *Bufo coccifer* I have found in Costa Rica were taken at night in the streets of Cartago. They come out usually after heavy rains. I have not found them breeding or calling. Specimens were taken August 26-27, 1947, and on August 28 and 29, 1951. A total of 28 specimens have been examined.

Bufo coniferus Cope

Figure 4

Bufo coniferus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 159 (type locality, Turbo Region, Colombia); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 321 (data from Cope); Proc. Zool. Soc. London, 1898, p. 123; Zool. Record for 1899, Rept., p. 29; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1901, p. 251, pl. 69, fig. B (La Palma and Carillo, Costa Rica) (Figure excellent); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 133 (Mexico to Ecuador [the species is not known to occur in Mexico]).

Chilophryne conifera Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 358 (listed only).

Iucilius coniferus Cope, *ibid.*, 1863, pp. 49-50 (listed only).

Bufo ehlersi Werner, Verh. zool.-bot. Ges. Wien, vol. 49, 1899, p. 481 (*vide* Günther and Nieden) (type locality, El Bergell, über Guaduas 1400 m. Colombia).

Diagnosis: A large species reaching at least 95 mm. in length; head with strongly developed crests; canthal crests terminate behind nostrils, the area between them being filled with osseous tissue leaving a plane surface between nostrils; supratympanic crest forming a thickened overhanging shelf; toes more than half webbed; parotoids

very small; tympanum large; trunk rather smooth on dorsal surface, with a dorsolateral row of large conical tubercles, 10 or 12 in number, extending from parotoid to groin.

Description of species: (From U.M.M.Z. No. 72029 ♀ "El General," Costa Rica). Head very rough, its width (33 mm.) much greater than its length (26 mm.); length of eye (7.2 mm.) less than snout length (8.3 mm.); distance between nostrils (4.2 mm.) much



FIG. 4. *Bufo coniferus* Cope. K.U.M.N.H. No. 30303; Moravia, Costa Rica; actual snout-to-vent length, 83 mm.

less than distance of nostril to eye (5.9 mm.); tympanum irregular, as high as wide (5 mm.); canthal crests more or less continuous with the supraorbital crests strongly curving to nostrils where they terminate at a level platform between the nostrils. At point where preorbital ridge descends, the crest is thickened; from this point back the supraorbital crests are parallel or nearly so; angle of supraorbital crest and the parietal crest nearly a right angle; the supratympanic crest forms a thickened beaded shelf above the tympanum; the postorbital crest is short; lower jaw with a beaded crest running

forward to anterior edge of eye. Upper lip and lower edge of lower jaw covered with dark horn as are the cranial crests; the horn often being somewhat beadlike; parotoid very small, its greatest length about 6 mm.; its width about 3.5 mm.; width of an eyelid 5.3 mm., much less than interorbital distance (13 mm. measured from outer edge of the supraorbital ridges).

The diameter of a choana (1.5 mm.) is contained in the distance between choanae (8 mm.), 5.3 times; tongue narrow, wider near the posterior end, about $\frac{1}{3}$ free; Eustachian tubes present, the openings not larger than choanae; transverse palatine ridges not distinct.

Arm long, more than half of the forearm extending beyond the tip of the snout; fingers long, slender, not webbed, the tips more or less covered with a brown horny material; proximal subarticular tubercles distinct; distal tubercles on outer fingers dim, scarcely separable from the flat, smooth, pavementlike granules under toes; palms smooth, with flat granules; a small inner metacarpal tubercle; a large subcircular outer palmar tubercle; leg rather long, heel to beyond tympanum; toes more than half webbed; outer metatarsal tubercle small (half length of toe), outer scarcely discernible; subarticular tubercle moderately distinct, flat; no tarsal fold or continuous row of tubercles.

The middle part of back relatively smooth, the few tubercles low, rounding, indistinct; interorbital region quite smooth; side of head with many fine tubercles, those back of jaw angle rather enlarged; a row of 10-12 large conical tubercles along side from parotoid to some distance from groin; upper surface of arms and legs with conical tubercles; chin, belly and sides with minute spinous tubercles, the spines obsolescent or absent on abdomen, and under femora; ventral and posterior part of thighs with relatively low conical tubercles bearing small spines.

Color: Slaty gray on dorsal surface, with some olive-slate marking or clouding; a diagonal gray stripe running back from parotoid; arms and legs banded with the olive, separated by gray areas; surface of the cranial ridges black; horny spines arising from the tubercles, deep black-brown; ventral surfaces dirty white with lighter and darker marbling; tubercles on femora light olive with brown spines; tips of digits black-brown.

Measurements in mm.: (K.U.M.N.H. No. 72029) Snout to vent, 84; length of snout, 8.3; length of head, 26; width of head, 33; eye, 7.2; tympanum, 5; arm, 66; hand, 27; leg, 112; femur, 38; foot and tarsus, 53.

Variation: The vocal sac in the male (K.U.M.N.H. No. 72021) has a single opening. The throat is not black, and the whole body is light fawn to brownish olive. The first finger is covered above and on the sides with nuptial asperities while the second finger is partly covered nearly to tip. A low vertical ridge is present on the tip of the nose.

Remarks: This large species occurs on the Pacific as well as the Atlantic side of Costa Rica, and its range extends well into Colombia and Ecuador. Reports of this species farther to the north in Mexico are very probably based on specimens of another species.

In 1951 I collected this species at Bataan and Moravia, Costa Rica. In life the general appearance of the two males taken at Bataan differed somewhat from the three males taken at Moravia; however the differences probably may be attributed to age differences, the Bataan specimens being smaller. All of the males lack the strong markings of the type. However two females, a large and a small specimen, do agree better with the typical markings. The larger, (K.U.M.N.H. No. 30303) measuring 83 mm. from snout to vent, was (in life) a brilliant leaf green on head, dorsum and sides of body, while on the ventral surfaces the color was dirty white with distinct mottling over underside of limbs, thighs and belly as far forward as a line between arm insertions. The underside of feet and tarsi are similarly marked. On the dorsal surfaces there is a black bar that passes across the head between the base of the parietal ridges, and beginning at the posterior terminations of these ridges, a deep black line diverges on to the shoulders. These lines widen, and soon terminate on the middle of the back. A pair of spots, rather narrowly separated mesially, run diagonally and terminate on the side. A pair of somewhat longitudinal spots are present somewhat in advance of the vent. The intervening surfaces between these spots are occupied by marks somewhat blackish brown but less strongly defined, the anterior being more or less connected mesially and likewise connects with a dark lateral irregular line. A pair of somewhat irregular spots are present on each side of the rump, also connecting with the lateral band. The limbs are strongly barred, the bars extending on to hand and foot. The back of the thigh is marbled with greenish, yellowish and black, and a second black band is present low on the side separated from the lateral dark mark by a yellowish green stripe following the line of enlarged conical scales.

In the young female (K.U.M.N.H. No. 30304, 43 mm.), the darker spots are well defined, and the intervening spots or blotches are

represented only by a slight clouding of darker color. In preservation the green disappeared in a few days and was replaced by grayish coloration.

The males all have single vocal slits; three are dextral, two sinistral. In none of the specimens can the supraocular crests be said to be straight. Adequate series from the type locality may show still further differences from the Costa Rican species here considered as *coniferus*.

Bufo luetkenii Boulenger

Bufo luetkenii Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 8, 1891, pp. 455-456 (type locality, Cartago, Costa Rica; A. S. Oersted, coll.); Günther, Biologia Centrali-Americana, Reptilia and Batrachia, May 1901, p. 253; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 184.

Diagnosis: A large toad, with a series of prominent crests or ridges on head; tympanum large, half as large as eye; parotoid smaller than an upper eyelid; first finger longer than second, all fingers with single subarticular tubercles.

Description of species: (From type, after Boulenger). Crown of head deeply concave, with prominent crests, a canthal, a preorbital, a supraorbital, a postorbital and an orbitotympanic (supratympanic); parietal ridges short, oblique, directed inwards; snout rounded, not prominent; interorbital space at least as broad as the upper eyelid. Tympanum very distinct, two thirds or three fifths of eye diameter; first finger considerably longer than second; toes half webbed with single subarticular tubercles; two small metatarsal tubercles; no tarsal fold. The tarso-metatarsal articulation reaches tympanum or eye. Dorsal surface with small irregular warts; parotoids very small, oval, oblique, not much larger than tympanum.

Color: Brown above, with or without yellowish spots; dirty white below, without any spots. Male with a subgular vocal sac, and copulatory (nuptial) asperities on the three inner fingers.

Measurements in mm.: Snout-to-vent length, 82.

Günther, *loc. cit.*, has added some information concerning the type: snout short, rather compressed, with sharp, nearly straight canthus; upper parts with few very small tubercles, a lateral series of somewhat larger ones from parotoid towards groin; lower parts finely granular, a series of small spines in place of a tarsal fold; a light vertebral band.

Distance from snout to vent, 78 mm. ♀; vent to metatarsal joint, 65 mm.; vent to end of fourth toe, 87 mm. It is presumed that this is the specimen listed as measuring 82 mm. by Boulenger.

The species was described by Boulenger from three specimens,

one of which is in the British Museum. The species is rare in collections. In my collecting in and near Cartago, I have not found it.

Bufo melanochloris Cope

Figure 5

Bufo valliceps var. Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 100 (eastern Costa Rica).

Bufo melanochloris Cope, Proc. Amer. Philos. Soc., vol. 17, 1877, p. 85 (type locality, eastern Costa Rica, W. W. Gabb, coll.); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 320; Günther, Biologia Centrali-Americana, Reptilia and Batrachia, pp. 252-253; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 134 (Costa Rica).

Diagnosis: A medium-sized toad with a crested head; diameter of tympanum about half of eye length; first finger longer than second; finger and toes long, nearly free of web; rather small parotoid glands and a lateral dermal fold present; greenish above with deep black spots; throat and thorax black.



FIG. 5. *Bufo melanochloris* Cope. K.U.M.N.H. No. 30275; 1 mi. W Pacuare, on Pacuare River, Costa Rica; actual snout-to-vent length, 42 mm.

Description of species: (From type, U.S.N.M. No. 30592). Head with a full set of crests; canthal crests relatively low forming a slight angle with supraorbital; supraorbital crests curving slightly inward so they are a little closer together midway in interorbital region; parietal crest well developed; supratympanic crest very strong, shelflike; parotoid moderate to small, diagonally placed; loreal region somewhat concave, sloping abruptly to lip; a ridge along upper edge of bone in upper jaw below eye; area about nostrils swollen, with a slight groove between them; a flat or slightly curved broad vertical ridge on snout; tympanum somewhat circular, a little higher than wide, its diameter 2.6 mm., a little less than half length of eye; length of eye approximately equal to length of snout.

Choanae large, the width of one (1.6 mm.) in distance between them (3.6 mm.), a little more than twice; tongue long, slender, free for more than half its length; (vocal slits present in males).

Arm covered with rough tubercles, long, the wrist reaching tip of snout or a little beyond; first finger larger than other fingers; hand with smooth tubercles, some minute, others variable in size; lateral ridges on second finger; a small inner metacarpal tubercle; larger outer tubercle; distal subarticular tubercles on fingers bifid; fingers without webs.

Foot and heel broad, the tubercles under feet rounded, high, not spinose, tips of toes slightly inflated, rounded, suggesting terminal discs; first two toes, a little less than two thirds webbed; outer toes about one third webbed; inner metatarsal tubercle moderately large, with a rather sharp free edge; outer tubercle conical; distinct, high, subarticular tubercles; legs covered with spinose tubercles; a row of similar tubercles replace inner tarsal fold; lateral ridges on toes; heel reaches eye; the heels, when the legs are folded at right angles to body, overlap 3 millimeters; back with scattered low tubercles; dorsolateral row of tubercles indistinct; venter, throat and breast with granular surfaces, the granules not flattened.

Color: Back gray-olive with at least 5 pairs of irregular black spots, some more or less connected longitudinally with a dusky gray marking; a dim lighter median line; spots beginning on eyelids are more or less connected by an intercalated pair of small dusky spots; somewhat broken blackish spots present on lips; thigh and tibia with indistinct darker bars; chin and breast dark, with lighter flecks; belly brownish or brownish white; brownish under femora.

Measurements in mm. of Bufo melanochloris Cope

Museum Number	{ U.S.N.M. 30592	M.C.Z. ^o 7932
Snout to vent	47	57
Width of head	18	22
Length of head	17	20
Length of snout	6	7
Tympanum	? x 2.6	4 x 3.4
Length of eye	6	7.1
Interorbital width	5.5	5.8
Width between nostrils	3.3	...
Width of eyelid	4.2	5.5
Arm	27	33
Forearm and hand	20	
Hand	10	14
Leg	56	59
Tibia	22	25.5
Foot and tarsus	26	29
Parotoid	...	6.5 x 3.4

Remarks: There are seven specimens in the K.U.M.N.H. collection, the largest of the lot measuring only 42 mm. They differ but little from the described specimens. Five of these were taken on the banks of the Reventazón where the highway to Moravia crosses it, and two at Pacuare on the road to Moravia. A part of these were found ensconsed in debris; others were hopping about in a slight shower. There are two specimens in the R.C.T. collection from the farm of the Inter-American Institute of Agriculture at Turrialba. The specimens are presumably all females, none showing nuptial asperities or vocal slits.

The most significant difference appears to be in the length of the third finger which is equally as long as the first, if not slightly longer.

There is a gray band between the eyes, bordered in front and behind by black; the median gray line is present in all. The median spots on forearm, thigh and tibia are much darker than other spots or bands. Much of the under surface of the thighs is yellowish white. The tympanum is separated from postorbital and supratympanic crests by a distance nearly half its diameter. The tympani, 2.3 mm. x 1.9 mm., are a little less than half of eye length (5 mm.). The greatest (diagonal) length of the parotoid gland is not greater than the length of the eye.

^o From Orotina, Costa Rica.

Bufo gabbi nov. nom

Figure 6

Bufo auritus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875) pp. 99-100, pl. 23, fig 4 (east coast region [= Talamanca], Costa Rica, Wm. Gabb, coll.), (nec *Bufo auritus* Raddi, 1821); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 321; Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, pp. 75-76 (data from Cope); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, May 1901, p. 256; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 11; Nieden, Das Tierreich, Lief, 46, Anura I, 1923, p. 134.

This small species still remains very rare. No data are published save those taken from the type specimens. The description here is drawn from one of the syntypes.

Diagnosis: A diminutive toad (31 mm. from snout to vent) with distinct crests, but lacking a preorbital crest; parotoid small surmounted by dermal spines; digits, especially fingers, elongate; heel reaches to nose; anterior half of tympanum visible; the Eustachian tubes with very small, triangular openings; toes a little more than half webbed; auricular region a somewhat projecting shelf.

Description of species: (From a syntype, U.S.N.M. No. 30676). Head generally triangular, casquelike, the top flat, the snout a little more elevated than the interorbital area, the canthal edges having the greatest elevation, bearing short beaded ridges, and a depression or groove between them; nostrils slightly swollen on side much below the canthus; a slight terminal dermal projection and a small vertical ridge from lip; loreal region with a depression running back from the dermal tip and terminating above the maxillary at anterior level of the preorbital ridge; the junction of the preorbital, canthal and supraorbital ridges swollen or thickened and the preorbital with a somewhat diagonal position; supraorbital crests somewhat angular around eyelid but actually they appear to be continuous with the parietals, which turn abruptly mediad toward their ends at back of occiput but do not touch; the combined crests parallel for most of their length; a vertical postocular and a supratympanic crest present; skin of the interorbital area co-ossified with the skull; the somewhat circular area above supratympanic crest almost completely enclosed by the ridges; when seen from above, the auricular shelf projecting forms "ears"; the length of the head equals its width at the auricular shelf (10 mm.); the eye large, its length (4.2 mm.) greater than length of snout; entire length of the orbit measured from ridges, 4.7 mm.; the measurement of the interorbital region 5 mm.; a ridge borders upper edge of upper jaw.

Choanae large, laterally placed; no vomerine teeth; tongue flat, thin, straplike; small triangular openings to the Eustachian tubes; tympanum not distinct save on its anterior edge. The processes of the second and third vertebrae are elongate causing the neck to be wider than the head.

Arm with a strong preaxial web, the wrist reaching beyond tip of snout; fingers especially long, unwebbed; the two outer longest; first finger shorter than second; numerous tubercles cover arm, and a row on the under surface tends to form a dermal fold; subarticular tubercles very indistinct; elongate inner metacarpal tubercle; a large palmar tubercle.

Leg long, heel reaches beyond snout tip. Foot about three fourths webbed on inner toes, two thirds webbed on outer toes; subarticular



FIG. 6. *Bufo gabbi* Taylor (new name). Redrawn from Cope, (*Bufo auritus*). *Journ. Acad. Nat. Sci., Phila.*, 2nd ser., vol. 8, 1875, plate 23, fig. 4; actual size, head and body, 31 mm.

tubercles scarcely discernible; heel broad, the inner metatarsal tubercle sharp, elevated; outer tubercle small, conical; seemingly there is an indistinct tarsal fold; toes pointed.

Skin of back somewhat tubercular, sides with spiny tubercles; under thighs and below on venter finely granular; a transverse row of four tubercles on the skin of neck; sides of neck at its widest part bordered by sharp spines; a skin fold from occiput curves around to the ends of the vertebral processes. Eyelid tubercular, the spines but little elevated; the parotoid gland very small with some spines.

Color: The color has faded so that it cannot be determined now.

The original color data states: "Color brown, a quadrate patch on vertex from orbits to occiput, an oblique band from the latter outwards on each side; and a spot on each lateral sacral region black; belly marbled with black, throat and limbs below dusky."

Measurements in mm.: (of a syntype, U.S.N.M. No. 30676). Snout to vent, 31; width of head, 10; length of head, 10; length of snout, 4; length of eye, 4.2; arm, 26 (23)*; hand, 10; leg, 43 (38); tibia, 13; foot and tarsus, 21.4 (21).

Remarks: It would appear that the name *Bufo auritus* used by Raddi °° for a Brazilian species of amphibia has been overlooked by Boulenger, Nieden and others. Since the name is preoccupied, a new name is necessary, and I propose the name of *gabbi* in honor of Wm. Gabb, its discoverer.

I am not aware that specimens other than the two cotypes are known. It has not been retaken since the discovery more than 75 years ago. One may presume that the species is confined to the Talamanca range. The type locality, so far as I know, has not been revisited by an herpetological collector since its discovery.

FAMILY BRACHYCEPHALIDAE

Representatives of two subfamilies of this family are present in Costa Rica: The Dendrobatinae with two genera of small toadlike forms, and the Brachycephalinae with one genus of somewhat larger frogs.

KEY TO THE SUBFAMILIES OF BRACHYCEPHALIDAE

Dermal scutes on dorsal surface of the digital discs Dendrobatinae
No dermal scutes on dorsal surface of the digital discs . . . Brachycephalinae

KEY TO THE COSTA RICAN GENERA OF BRACHYCEPHALIDAE

1. A pair of dermal scutes on the upper surface of the somewhat dilated terminal digital pads; an omosternum present, either of cartilage or bone; toes without distinct webs (present in *Hyloxalus* which is not known as yet in Costa Rica) 2
No dermal scutes on the upper surface of digital tips; no omosternum present; toes webbed the foot somewhat palamate . . . *Atelopus*
2. Maxillary teeth present (except *P. truncatus*, *fide* Dunn) . . *Phyllobates*
No maxillary teeth present *Dendrobates*

* The original measurement of arm and leg are somewhat less than my estimated measurements. The arm is folded and cannot be straightened without damage to the specimen. This perhaps was true also when measured by Cope.

°° Raddi, Giuseppe, *Continuazione della Discrizione der Rettili Brasilini*. Mem. Nat. Fis. Soc. Ital. Sci. Modena, vol. 19, 1821, p. 71.

Subfamily Brachycephalinae

Only a single Costa Rican genus of this subfamily is known.

Genus *ATELOPUS* Duméril and Bibron

Type of genus: *Atelopus flavescens* Duméril and Bibron.

The frogs of this group are often brightly colored; the dorsal color being black, olive, yellow and red. They are usually slow moving and at least certain of them often move by walking rather than by hopping.

The confusion mentioned by previous writers as existing in the genus *Atelopus* still exists. Dunn (1931) has reported on certain forms occurring in Panamá. He lists five forms all belonging to *Atelopus varius*, and later he (Dunn, 1933) describes another subspecific form from El Valle de Anton in the northwestern corner of Panamá. Of the six forms recognized in Panamá it would appear that *Atelopus cruciger* might better be treated as a distinct species from *varius*.

The frogs of this group, as they occur in Costa Rica, have been difficult to treat, since the collections are inadequate from single localities and adequate series from adjoining countries likewise were not available. The arrangement here given must be regarded as tentative and at the same time, incomplete.

I am recognizing *Atelopus varius varius* in Costa Rica, and I here propose names for two other subspecies, *Atelopus varius loomisi* and *Atelopus varius ambulatorius*. Another form *Atelopus senex*, I describe as a new species.

Aside from these four forms, I have seen certain Costa Rican specimens in the collection at Harvard College. With further study it may well be possible to recognize other subspecific forms in material now in collections.

Two specimens examined in the Harvard, M.C.Z. collection (Nos. 16021, 16022 from the northwest slope of Mt. Carpinteria, Costa Rica, C. W. Dodge coll.) differ markedly from the forms here considered. The color characters of these are as follows:

Body above uniform dark brown on top and sides with a series of cream or yellow spots (in preservative) arranged symmetrically on the dorsum. On head a medial longitudinal mark followed by a pair of short transverse marks; on sides of shoulders a pair of elongate marks; near sacral region two diagonal marks followed by a somewhat rounded median mark; on rump two or three small spots, one on thigh, two on tibia; belly cream, the under side of

hands and feet similar to venter but somewhat more orange; a cream line on lip; a mark across arm insertion to elbow, and irregular black marks on venter. The absence of red colors may be due to fading.

No. 16023 Harvard, M.C.Z. A small form from Tres Rios, Cartago Province, C. R., has black paired spots on back; a chevronlike mark on snout and white marks over the temporal region.

No. 7943 Harvard, M.C.Z. Navarro, C. R., has finely divided black and olive-cream markings. The toes are not fully webbed (webs deeply excised). Venter strongly reticulated with brownish black; chin finely reticulated with dusky.

Adequate collecting in Costa Rica may determine whether these individuals are members of separate populations or whether they are variants of a single population.

Boulenger, in his Catalogue of the Batrachia Salientia . . . , distinguishes two Costa Rican varieties (1882, p. 153). He suggests that the second variety, "grayish above dotted with black, the light markings black-edged" are probably males, yet he lists both males and females in his variety 2.

While it is possible that there is considerable sexual difference, it seems wholly unlikely that *Atelopus varius ambulatorius* (R.C.T. No. 760, figured) could possibly be the male of either of the two females depicted herein: *Atelopus senex* (R.C.T. No. 765) or *Atelopus varius loomisi* (K.U.M.N.H. No. 24746).

KEY TO COSTA RICAN FORMS OF ATELOPUS

1. A strongly developed supratemporal ridge or boss; uniform gray-olive above, dirty whitish on ventral surfaces without markings, (38 mm.) *senex*
 Temporal ridge less strongly developed; body bi- or tricolored dorsally in black, red or yellow 2
2. Venter orange-red and black, black and yellow above, no red on dorsum, larger, (44 mm.) *varius loomisi*
 Not orange-red on venter, red may be present in dorsal coloration, 3
3. Dorsum black with red and yellow markings; venter yellow or cream with or without dark spots; larger, (40 mm.) *varius varius*
 Dorsum greenish yellow with narrow black markings; venter yellow, chin cream with or without dark marks; smaller, (33 mm.) *varius ambulatorius*

Atelopus varius varius (Lichtenstein and von Martens)

Atelopus varius Stannius, In Handbuch der Zoologie, von Siebold und Stannius, 2 auflage, 2 buch; Zoologie der Amphibien, Ed. 2, 1856, p. 16. (*nomen nudum*); Peters, Monatsb. Akad. Wiss. Berlin, Feb. 16, 1863, p. 82. (refers the genus *Phrynidium* to *Atelopus* Duméril and Bibron); Keferstein, Nachtr.

- k. Ges. Wiss. Göttingen, 1867, pp. 350-351 (Costa Rica, von Seebach coll.); Keferstein, Arch. für Naturg., Jahr. 34, vol. 1, 1868, p. 292, pl. 8, figs. 33, 34 (length of body 40 mm.; leg 53 mm.; Costa Rica.); Cope, Jour. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 102. (*part.*) ("Very abundant on the Pico Blanco range, and in the lower country. The markings are vermilion on a black, or in the case of mountain specimens, a green ground. In some of the latter the red markings are few, and in others altogether wanting, leaving a uniform pea-green"); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, pp. 208-209, pl. 62, figs. A, B, C (*part.*); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 96, pl. XI.
- Hylaemorphus Pluto*, Fitzinger, in Schmidt, Denks. K.K. Akad. Wiss. Math.-Natur. Cl. Bd. 14, 1857 (1858), p. 255 (Costa Rica, Dr. Scherzer, coll.).
- Phrynidium varium* Lichtenstein and von Martens, Nomenclator Reptilium et Amphibiorum Musei Zoologici Berolinensis . . . 1856, pp. 40, 41, Berlin (Veragua, Panamá); Cope, Jour. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, 1867, p. 196.
- Phrynidium varium adpersum* Lichtenstein and von Martens, Nomenclator Reptilium et Amphibiorum . . . 1856, p. 41.
- Phryniscus varius* Günther, Catalogue of the Batrachia Salientia in the collection of the British Museum, 1858 (Feb. 12, 1859) p. 45; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the British Mus., ed. 2, 1882, p. 152.
- Atelopus varius varius* Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 393-397 (upper Costa Rica; Panamá); Wettstein, Sitzungsab. Akad. Wiss. Wien, Math.-Naturw. Kl. abt. 1, Bd. 143, Heft 1 und 2, 1934, p. 7 (La Carpintera).

It is probable that some of the above synonymy is not wholly referable to *Atelopus varius varius*.

The original description in the "Nomenclator Reptilium et Amphibiorum Musei Zoologici Berolinensis" is extremely brief: *Phr. varium nob. Rostro longiusculo. Supra nigrum, flavomaculatum labiis apicibusque digitorum flavis; subtus flavum*. For one of the subspecies, which Dunn chose as the synonym of the typical form (*adpersum*), the description given is as follows: *minus, rostro paulo breviori, maculis dorsi clavatis, ellipticis, parvis, frequentibus, modo flavis modo rubris; pedibus flavomaculatis; abdomine modo unicolore flavo, modo maculis parvis raris rotundis nigris insignito. Long. corp. [1 $\frac{2}{3}$ inches?]*.

While the types were from Veragoa [= Veragua, Panamá] Keferstein (1867) reported the species in Costa Rica. Dunn^o has reported the typical form in San José and "upper Costa Rica."

Günther (Biologia Centrali-Americana, Reptilia and Batrachia, 1900, pp. 208-209) has placed Schmidt's *Hylaemorphus dumerilii* and *Atelopus varius maculatus* Peters as a synonym of what he calls *Atelopus varius*. Under the latter name he has reported specimens from Guatemala; Costa Rica (Bebedero, Escazú, Izaru [= Irazú?], San Marcos, Tivas elev. 1000 m., Santa Clara 400 m.; Panamá (Veraguas, Chiriquí).

^o Dunn (1931, p. 394). gives a reference (Stannius 1856, *Handb. Zool.* 2, p. 16), that I am unable to find.

It is perhaps significant that he does not place in synonymy *Phryniscus cruciger* [Lichtenstein and von Martens] which seemingly should be regarded as a species distinct from *varius*.

Diagnosis: A medium-sized subspecies reaching a length of approximately 40 mm.; skin smooth, snout elongate. Black above with small markings of red, pink, green or yellow; venter yellow or yellow with some black spotting.

Description of subspecies: (From Keferstein 1867 and 1868). Head short flattened, the eyes scarcely protruding; body slender, narrow; dorsum and head entirely smooth; a small web between the two inner fingers; all toes bound together with large webs, that on the inner toe reaches to the tip; on the fourth and longest toe webs reach only halfway except that a narrow fringe reaches the tip in all cases. A very small web between the two inner fingers. Sole of foot broad, smooth; no tubercles even on metatarsus except a tiny, scarcely noticeable tubercle on the outer metatarsus. A skinfold on the inner side of metatarsus. The entire dorsal surface is brownish black with reddish flecks; venter uniform bright golden yellow. Low on sides of head and on sides of the body golden yellow like venter. Sometimes the darker ground color, sometimes the dorsal flecks of red or yellow predominate. Snout to vent, 40; leg, 50. Costa Rica.

Remarks: I collected no specimens of this form and any material I have seen that may belong to the subspecies has been faded. Günther's *Biologia Centrali-Americana*, pl. 62, fig. A, (1900), seemingly is a good illustration of this form.

Atelopus varius loomisi * subsp. nov.

Figure 7

Type: K.U.M.N.H. No. 24746, Isla Bonita (American Cinchona plantation), approximately 5000 ft. elevation, eastern slope Volcán Poás, Costa Rica, Richard C. Taylor and Edward H. Taylor colls.

Paratypes: K.U.M.N.H. Nos. 24742-24745: R.C.T. Nos. 835-836; 2458: 2459 all topotypes, same collectors.

Diagnosis: Black and yellow above, with orange-red color below; snout narrow, with nearly vertical sides; no teeth of any kind in the mouth; tongue rather narrow, elongate; tympanum absent; nostril about halfway between eye and tip of snout; fingers nearly free; toes nearly fully webbed.

* The subspecies is named for Mr. Richard B. Loomis who has assisted me greatly in criticising the manuscript and in reading proof.

Description of type: Head narrower than body its width (12 mm.) very slightly greater than length (11.5 mm.); canthus rostralis distinct but slightly rounding, the edges raised above the level of the snout; snout extending beyond mouth, in profile sloping sharply back and down to lip; nostril distinctly lateral, below canthus, the area surrounding nostrils much swollen leaving a depressed area in loreal region between eye and nostril; eyes prominent, the upper lid forming a shelf above eye, its edge bearing a somewhat thickened fold; above tympanic region a heavy thickened crest, terminating

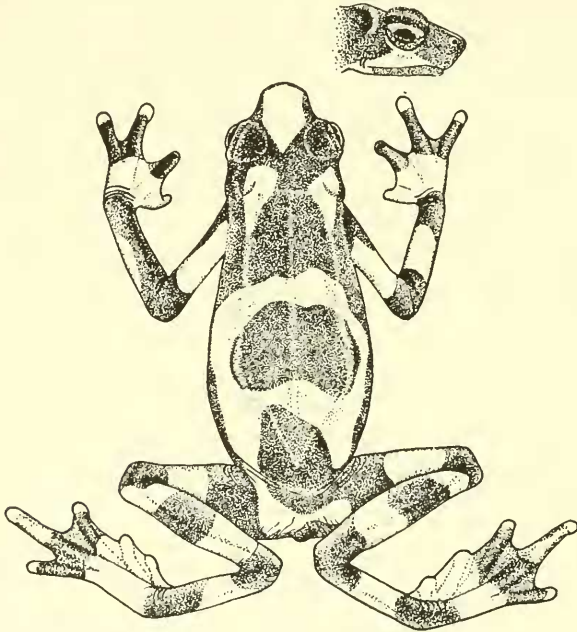


FIG. 7. *Atelopus varius loomisi* subsp. nov. K.U.M. N.H. 24744; Isla Bonita, Volcán Poás; Actual snout-to-vent length, 44 mm.

posteriorly in a somewhat elevated, rounded knob; width of an eyelid about equal to interorbital distance or a little greater; length of eye (3.5 mm.) greater than its distance from nostril (3.1 mm.), but less than snout length (4.7 mm.); tympanic area slightly depressed.

Vomerine and maxillary teeth absent; choanae lateral, concealed by maxillary shelf when examined from below; tongue narrow, elongate flaring somewhat posteriorly, unnotched; behind free for nearly half its length.

Skin smooth above and below save for some wrinkling in the

median thigh region and below vent, which opens near upper level of thigh; the very short anal flap somewhat crenulated; beginning on side of head in tympanic region series of small pearl-tipped pustules continue some distance on the sides. Ventral surface broken by longitudinal and transverse wrinkles or grooves.

Arm slender, the three outer fingers practically lacking web; however the first finger is short, scarcely more than its tip extending beyond the thickened web; second finger shorter than fourth the webbing scarcely indicated; tip of digits rounded, without discs or pads; subarticular tubercles very indistinct; an indistinct tubercle at base of first finger and an outer palmar tubercle of large area, scarcely elevated; some supernumerary tubercles indicated on palm.

Leg short, when adressed the tibiotarsal joint fails to reach eye; foot with inner and outer metatarsal tubercles weak; subarticular and a few supernumerary tubercles faintly indicated; web includes first-toe and most of second; on third the web does not reach tip on inner side; three joints of the fourth toe free but with a fringe indicated to near tip; slight suggestion of an inner tarsal ridge or tubercle near first toe.

Measurements in mm.: Snout to vent, 44; width of head, 12; length of head, 11.5; arm and hand, 32; leg, 57; tibia, 19; tarsus and foot, 30.5.

Color: Coal-black on lemon-yellow; an enclosed yellow area on top of snout; a black line follows the canthus, passes above and below eye, and continues down across tympanic area and onto arm; black mark between orbits continues back, then divides, widening on sides behind arms. A large bean-shaped mark on back placed transversely; a large black groin spot connecting across rump with one from opposite side; arms and legs with black bands, tips of digits yellow; upper lip yellow, edge of lower lip black; chin, venter and under surface of limbs orange-red; a few rounded black spots on venter.

Remarks: A series of ten female specimens are at hand. These agree remarkably well save for the details of the design on the dorsum. The measurements of the series is uniform, varying from 41-44 mm. snout-to-vent length. All contain large ovarian eggs without pigment.

It is not impossible that the Costa Rican specimen figured as *Atelopus varius* Stannius by Brocchi (Miss. Sci. au Mexique . . . part 3, sec. 2, livr. 2, 1882, p. 96, plate 11, figs. 1, 1a-1d) belongs with this subspecies.

Atelopus varius ambulatorius subsp. nov.

Figure 8

Type: R.C.T. No. 766, Isla Bonita (American Cinchona Plantation) southeastern slope Volcán Poás, elevation approximately 6000 ft. Richard C. Taylor, coll. 1947.

Diagnosis: A rather small form, related to, but differing from *Atelopus varius varius* in having a ground color dorsally greenish yellow, ventrally cream-white on chin and throat, but becoming dull yellow on venter and concealed part of limbs, and lacking any trace of the red or orange-red coloration. On back a more or less

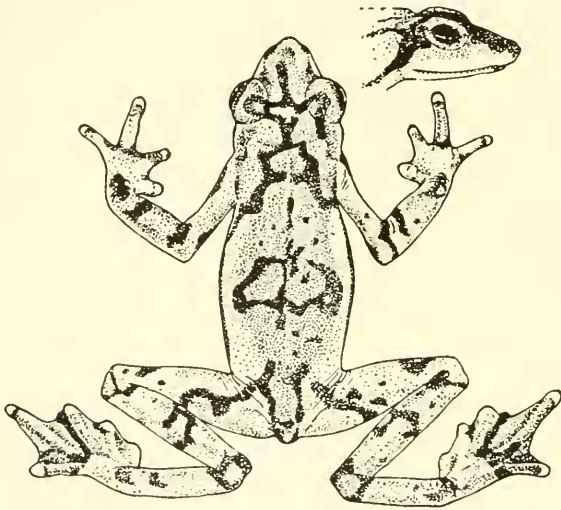


FIG. 8. *Atelopus varius ambulatorius* subsp. nov. Type R.C.T. 766; Isla Bonita, Volcán Poás: Actual snout-to-vent length, 33 mm. adult male.

symmetrical pattern of black with a black diagonal line on side from groin to eye; few very small dots of black on venter; no tympanum, the supratympanic ridge not elevated; fingers nearly free, toes fully webbed; no teeth.

Description of type: (From R.C.T. No. 766, Isla Bonita, C. R.). Probably a small species, the known snout-to-vent measurement, 33 mm.; head width (9.2 mm.) approximately equal to head length (9.4 mm.) canthus distinct, the loreal region strongly concave, the upper part of lores vertical, the lower sloping obliquely to lip; no visible tympanum; a low supratemporal ridge slightly evident; eye projecting; the eyelid bearing a thickened ridge near its outer edge

forming a strong projection, beyond the canthus or temporal ridge line; length of eye (3.5 mm.) approximately as long as snout (3.6 mm.); width of an eyelid (2.9 mm.) slightly less than interorbital interval (3.2 mm.) (one eye is lost from some earlier accident, and the lid tightly closed over the cavity); area about nostrils swollen somewhat, the width of snout at nostrils greater than width immediately behind them; a distinct broad depression on the snout; in profile snout pointed, then sloping back and down to lip, extending forward beyond lip a little more than 1 mm.

Choanae small, lateral, widely separated; palatal glands open into two pits between hind level of choanae; a pair of white (glandular?) areas between and largely behind hind level of choanae; membranes of upper roof of mouth posteriorly cut into contiguous variiform tracts; ostia pharyngea minute, less than a fourth size of the small choanae; tongue small, slender, wider behind than in front, free for half its length; vocal slits long, rather posterior in position.

Arms long, the major part of forearm extending beyond the tip of snout; first finger short, thick, broader than other digits, much shorter than second; a web between the two inner fingers reaches to the small subterminal pad or disc; between second and third fingers less than a third webbed; between outer fingers only a small vestige of web evident; the webs much thickened, seemingly forming a part of the palm; pads or discs under finger tips not wider than digits; latter have no lateral ridges or terminal grooves; inner metacarpal tubercle large; low palmar tubercle equally as large but rounding; first finger with a large nuptial swelling with minute asperities covering entire upper surface of the digit; subarticular tubercles distinct, rather flat.

Leg short the heel reaching to back edge of eye; heels barely touch when legs are folded; toes fully webbed with some emargination, the web fringe reaching tip of even the fourth toe; the webs all thickened forming part of sole; inner metatarsal tubercle large, flat, indistinct; outer smaller, rounded, perhaps more elevated; subarticular tubercles small, indistinct.

Skin above nearly smooth, but under a strong lens a few minute pearly spinules are visible in the temporal region and in front of arm where there is also a slight tuberculation; skin of venter longitudinally and transversely wrinkled or grooved, breaking the surface into a pavement of small angular areas suggesting granules; under surface of thigh more or less distinctly granular; vent high, protruding, surrounded by narrow, closely-juxtaposed, fingerlike crenulation.

Color: In life greenish yellow above with series of black narrow lines forming a somewhat symmetrical pattern; sides dull yellowish with a black diagonal streak from eye to groin where it terminates by forming a sharp angle and turns diagonally forward; chin cream-white; venter and light areas of limbs dull yellow, with a few scattered tiny black dots on throat, some on sides and a few on venter; a pair of median black marks on ventral surface of thighs; underside of foot with toes black and a transverse dark mark across front of sole; three outer fingers black below; dark marks across arm and leg (see figure). A dark canthal line passing around tip of snout. A black mark from behind eye onto foreleg.

Measurements in mm.: Snout to vent, 33; width of head, 9.2; length of head 9.4; length of eye, 3.5; length of snout, 3.6; arm, 22; hand, 8.5; leg, 43; tibia, 14.5; foot and tarsus, 20.

Remarks: This subspecies was discovered at night perched on a large leaf of a plant growing in the forest near a small stream. In the same general region, but at a considerably lower elevation, I took another, presumably much larger form, *Atelopus varius loomisi*, and at a still higher elevation, across the divide a few miles westward is the type locality of *Atelopus senex*. Because of the lack of female specimens and the absence of striking structural characters, I feel it wiser to regard this as a subspecies rather than as a distinct species.

Atelopus senex sp. nov.

Figure 9

Type: R.C.T. No. 766; near pass between Volcán Poás and Volcán Barba, western slope Volcán Poás, Pacific drainage, elev. app. 6800 ft.

Diagnosis: A medium-small species of the genus, lacking all spots or specific markings; snout narrowed, the tip with a rounded point distinctly projecting beyond lip; a depression on snout between canthi; suprascapulae form prominent ridges on shoulders; thickened web at base of fingers; toes nearly fully webbed; a distinct bony temporal ridge from eye, and a distinct postorbital ridge branching from it; heel reaches only to postorbital ridge; numerous conical tubercles in groin, scattered on sides of body and neck, and on the front face of upper arm.

Description of type: Body slender its length 38 mm., the skin rather tightly drawn around body leaving the sacrum definitely outlined and the vertebral ridge in evidence. Head rather angular, the canthus well defined, the canthal edges somewhat elevated with

a depression between them extending from frontal region to near tip; the loreal region nearly vertical, but with a concave depression in front of eye, and a depression and groove below the somewhat swollen nostril, the depression tending to continue around tip of snout; a strong medial notch in upper lip; nostril a little closer to tip of snout than to eye, but nearly equidistant from eye and from the median notch in upper lip; no trace of tympanum; length of eye (3.3 mm.) slightly longer than distance between eye and nostril, much shorter than length of snout (4.5 mm.); temporal ridge marks



FIG. 9. *Atelopus senex* sp. nov. Type. R.C.T. No. 766; near the divide between Volcán Poás and Volcán Barba; snout-to-vent length, 38 mm.

widest part of head (10 mm.) the width less than head length (12.1); width of eyelid (3 mm.) less than interorbital interval (4 mm.).

Choanae vertically oval, lateral; no vomerine teeth; palatal glands open in a deep pit midway between choanae; maxillary teeth absent; tongue very small, narrow, free for half its length; ostia pharyngea minute, one eighth or one tenth size of choanae. Membranes of roof of mouth back of orbits with strong vermiculate grooves; two small white glandular (?) areas between and slightly posterior to choanae.

Arms slender, long, more than half of forearm extending beyond tip of snout; digits of hand with small terminal pads, or discs, not

or scarcely wider than digits; subarticular tubercles large, flat, ill defined; webbing greatest between first two fingers (from disc to subarticular tubercle of second); scarcely more than a vestige between the outer three fingers, in all cases the web is thickened, seemingly forming a part of the palm; inner metacarpal tubercle large, poorly defined; palmar tubercle large, better defined; (right hand deformed, one digit entirely missing); conical tubercles on front face of upper arm, and on neck preceding arm insertion.

Leg short, the heel barely reaching the supratemporal ridge; when legs are folded the heels fail to touch by a distance of three mm.; toes fully webbed, with small subterminal discs, the tips not wider than the digits; subarticular tubercles ill defined; a flat ill-defined inner metatarsal tubercle; a smaller more distinct outer; subarticular tubercles weak.

Skin rather smooth with scattered small tubercles on sides of body, stronger in groin and on neck; venter not typically granular but skin wrinkled longitudinally and to a lesser extent transversely; a few granules on the chin, none or only very indefinite granules on under side of thigh; vent opening near upper level of thigh.

Color: In life, olive above, head dull greenish yellow; lips lighter, more yellowish; groin, chin and venter dull yellow. In preservation color dull brownish gray above, lighter on elbow and heel, and on the supratemporal ridges and in the frontal area; the skull is semi-transparent and the brain can be discerned as two yellowish spots.

Measurements in mm.: Snout to vent, 38; width of head, 10; length of head, 12.1; depth of head, 6; length of eye, 3.3; width of sacrum, 12; arm, 26; hand, 11; leg, 45; tibia, 14; foot and tarsus, 24.

Remarks: The specimen, collected by Richard Taylor, was found walking slowly near a small rivulet late in the afternoon. The prominence of the suprascapulae, the slightly overhanging supratemporal ridges, the widened sacrum with the slight depression of the dorsum give the animal a strange appearance. The figure given shows most of these characters rather faithfully.

The habit of walking rather than hopping has been observed in certain other species of the genus.

Subfamily Dendrobatinae

Two genera, *Phyllobates* and *Dendrobates* belonging to the Dendrobatinae occur in Costa Rica, and it is not improbable that a representative of *Hyloxalus* will eventually be discovered in the country.

Genus DENDROBATES Wagler

Dendrobates Wagler, Natürliches System der Amphibien, 1830, p. 202. Type of genus: *Dendrobates tictorius* (Schneider).

These small Costa Rican frogs of the genus *Dendrobates* may be distinguished from the species of *Phyllobates* in Costa Rica by the absence of teeth in the maxillary and in life by the very striking coloration involving black and brilliant greens, reds and blues.

KEY TO COSTA RICAN SPECIES OF DENDROBATES

- Small toadlike species, 20-22 mm. snout-vent length; body vivid red, limbs blue in life; all black in preservation or rarely speckled with black on a somewhat lighter ground color. Eastern lowlands of Costa Rica *typographus*
- Larger, 29 mm., dorsal as well as ventral parts of body and limbs golden green and black in life; in preservative the green is replaced by blackish gray or silver *auratus*

The coloration of these small forms makes them very conspicuous where they occur. They are especially active, and in places where I found them, they were very adept in escaping capture. The vivid colors disappear in a few hours when they are placed in a preserving fluid and there is left small evidence of the former brilliant coloration.

Dendrobates typographus Keferstein

Dendrobates typographus Keferstein, Nachtr. könig. Gesell. Wiss. und der Georg-Augusts Univ., Göttingen, 1867, p. 360 (type locality, Costa Rica, von Seebach coll.); Arch für Naturg., 34 Jahr, vol. 1, 1868, p. 298, pl. 9, fig. 7 (same data as preceding article); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 102 (places *D. ignitus* in synonymy of this species); U. S. Nat. Mus. Bull. 32, 1887, p. 19, Nicaragua, Moser and Bransford colls.; E Costa Rica, Gabb coll.).

Dendrobates ignitus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1874, pp. 68, 69 (type locality Nicaragua; F. Bransford coll.).

Dendrobates pumilio Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, p. 393, 394 (places *typographus* as a synonym).

Dendrobates pumilio Wettstein, Sitzungb. Akad. Wiss. Wien math.-natur. Classe, Abt. I, Bd. 143, Heft 1-2, 1934, pp. 6-7 (Hamburg Farm on the Río Reventazón, Koller coll., and Carillo on Río Sucio, circa 200 m. elev., Koller coll.).

Diagnosis: Body small (20-22 mm.) squat, toadlike; limbs short, the toes and fingers free; terminal finger discs growing progressively larger from first to fourth; toe discs of first and fifth toes smallest; first and second fingers nearly equal measured on inner edge, or when juxtaposed, second a little longer; no teeth present in mouth; toes with two separate pads on top of the digital discs; body red (in life), arm and legs blue; in formalin preservation, black all over with (in some specimens) a silvery surface with black dots.

Description of species: (From K.U.M.N.H. No. 24892, Los Diamantes, C. R.). Head length (7.6 mm.) a little less than head width (6.9 mm.); eye large, its length (2.16 mm.) equal to snout length; nostril nearly terminal, the distance of nostril to median notch in lip, less than its distance from eye; no distinct canthus rostralis; loreal region vertical; snout broad, truncate, but slightly rounded seen from above; snout extending slightly beyond mouth and sloping back to lip when seen in lateral profile; eyelid width (2 mm.) two thirds of interorbital distance (3 mm.); tympanum visible but somewhat indistinct on its upper border, 1.5 mm. in vertical diameter. Choanae seen from below partially (or almost wholly) concealed by maxillary shelf; no vomerine teeth; maxillary shelf grooved below; no teeth present on jaws; tongue elongate, narrow, three times as long as wide, free for half its length.

Arm moderately long, slender; fingers without trace of web; the tips widened into distinct discs, progressively larger from first to fourth, with a maximum width of .75 mm.; first finger nearly or equally as long as second, but when juxtaposed the second extends farther; tibiotarsal articulation (heel) reaches eye when leg is drawn forward; discs of first and second toes smaller than those on other toes; edges of toes with a minute ridge, but without web; subarticular tubercles of both hands and feet flat, inconspicuous; a small metacarpal tubercle at lower base of first finger; a large, rounded, median, slightly-elevated palmar tubercle; inner and outer metatarsal tubercles distinct, subequal; a small, short, distinct, inner tarsal ridge or tubercle (somewhat variable in length).

Skin generally smooth but close scrutiny of the dorsal surfaces under a lens discloses very fine pustules; venter smooth except a fold or long ridge on each side of abdomen (similar to folds in *Eleuthrodactylus* marking ventral discoidal discs); a broad thick anal flap; under surface of thigh with an indistinct granular surface.

Color: In preservation nearly uniform grayish; in life the greater part of the body bright red or orange-red, the limbs blue.

Measurements in mm.: (K.U.M.N.H. No. 24892). Snout to vent, 22; width of head, 6.9; length of head, 7.6; arm and hand, 15; leg and foot, 30; tibia, 10; tarsus and foot, 13.

Variation: This small but conspicuous species of amphibian was found to be common in the lowland region about Los Diamantes, (near Gúapiles) Costa Rica. Some 47 specimens are present in the collections from Los Diamantes. One specimen was captured at Bataan.

The lateral abdominal folds are sharply distinct in the described specimen but in some it is less distinct. Males are equally as large as females, but the throat and breast in these have the skin loose and granular, marking externally a vocal sac; vocal slits large, rather posterior; in females a fold in the membrane of mouth is present in the usual position of the slits.

Dunn, (*loc. cit.*) has suggested that the name *pumilio* Schmidt is applicable to this species. It is a form described by Schmidt (Akad. Wiss. math.-natur. Classe. Wien, vol. 15, 1857 (1858), p. 250, pl. 11, fig. 13) and its type locality is given as follows:

“Das Vaterland unserer drei Species ist das Grenzgebiet zwischen New Granada und Costa Rica, der weg zwischen Bocca del Toro und dem Volcan Chiriqui . . . der immergrünen Regionen zwischen 5000 und 7000 ft.”

The figure, pl. 2, fig. 13, shows a species that could scarcely be regarded as belonging to the species here described as *typographus*. Until a comparison of the types of *pumilio* and *typographus* by a competent observer proves them to be identical, I propose to use the Keferstein name. Cope believed his *D. ignitus* to be identical with *D. typographus*.

Dendrobates auratus Girard

Phyllobates auratus Girard, Proc. Acad. Nat. Sci. Philadelphia, Dec. 1854 (1855), p. 226 (type locality Taboga Island in the Bay of Panamá, C. B. Adams, coll.); U.S.N. Astronomical Expedition to Chili, vol. 2, p. 209, pl. 34, figs. 12-15 (side and ventral view natural size; underside of hand and foot somewhat enlarged.); Eaton, Copeia, 1941, No. 2, July 8, pp. 93-95; Dunn, Copeia, 1941, No. 2, July 8, pp. 88-93.

Dendrobates tinctorius var. *auratus* Steindachner, Verhandl. k.k. zool.-bot. Ges. Wien, 1864, p. 261, pl. 13, figs. 1, 1a-1d (In separate, pp. 22-24); Cope, Journ. Acad. Nat. Sci. Philadelphia, 2nd ser., vol. 8, 1875, p. 102. (“Numerous and exclusively from the low country not extending far inland.”)

Dendrobates tinctorius (*part.*) Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 1882, pp. 142-143.

Hylaplesia auratus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1863, p. 49 (points out certain “imperfections” in Girard’s description.).

? *Hylaplesia tinctoria latimaculata* Günther, Catalogue of the Batrachia Salientia in the British Museum, 1858 (1859), p. 125 (Isthmus of Darien).

? *Dendrobates trivittatus* var. *maculata* Peters, Monats. König. Akad. Wiss. Berlin, 1873, p. 617. (Chiriquí, M. Wagner coll.) “Der erste Finger ist, wie bei den typischen Exemplareu (*sic*) etwas länger als der zweite. Oben und unter mit mehr oder weniger zahlreichen goldgelben Flecken gezeichnet.”

? *Dendrobates amoenus* Werner, Verh. zool.-bot. Ges. Wien, vol. 51, May, 1901, pp. 627, 628, (type locality, Costa Rica), (Generic review).

Dendrobates auratus Dunn, Occ. Papers, Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, p. 393; *ibid.*, Oct. 10, 1931, p. 412 (three records mentioned for Barro Colorado Island).

Eight specimens of this species were taken by me at Bataan, eastern lowland Costa Rica between July 20-24, 1951.

The type description given by Girard is from a specimen captured on Taboga Island, Bay of Panamá. It has been discolored by preservatives.

Diagnosis: Small frogs snout-to-vent 39 mm.; brilliantly colored above and below in green and black or golden yellow and black; lacking any webbing; distinct tympanum close to eye, the eye as long as snout; a ventral "disc" present; fingers with widened terminal discs; no maxillary or vomerine teeth; ostia pharyngea as large as choanae.

Description of species: (Details from Girard's type description). Body and head elongated depressed; head subtriangular, subtruncated anteriorly sloping inward, its length a little less than one third of the snout-vent length; nostrils small, lateral, near the tip, not visible from above; sides of head declivous; eyes large subelliptical, their horizontal diameter equal to distance of eye from tip of snout, twice as wide as distance between outer margins of eyelids; tympanum well developed, oblong, close to orbit; mouth angle extends to posterior rim of orbit; tongue narrow, elongate, posteriorly obtuse, free for half or two thirds of its length; choanae very large, subcircular, widely separated on roof of mouth, which is concave and perfectly smooth, there being no maxillary or vomerine teeth; openings of the Eustachian tubes small, not conspicuous; arms slender, the fingers reaching beyond groin; fingers free, slender, dilated at tip, the discs above divided by a groove or furrow; a large metacarpal tubercle, smaller tubercles present under first phalanx and also under second of the two external fingers; palm smooth; first finger longer than second, the fourth shortest and most slender of all. Legs stoutish, one fourth longer than body and head together, the tibia being better developed than femur; toes free, slender, depressed dilated at tips and grooved above on discs; sole smooth, the phalanges with subarticular tubercles; internal metatarsal tubercle elongated the outer rounded; both moderately developed; inferior surface of thigh granular, the skin otherwise perfectly smooth, but exhibiting minute pores under a lens, both above and below.

Color: Above metallic golden; beneath a uniform bluish predominates.

Measurements in mm.: (taken from K.U.M.N.H. No. 30292). Snout to vent, 39; width of head, 10.2; length of head, 10; length of arm, 25; leg, 52.5; tibia, 13; foot and tarsus, 22.5.

Remarks: The details of the figure given differ somewhat from

the detailed description; as, for instance, the outer metatarsal tubercle is elongated, the inner rounded instead of the opposite as stated in the description.

Cope (P.A.N.S. Phil. 1863, p. 49), who seemingly had Girard's specimens before him gives the following additional data. Muzzle rounded; first finger shorter than second as in *tinctoria*; no occipital ridges, the neural spines only slightly thickened, discs on toes one fourth of extent of tympanum; discs of fingers one half of same; ground color black or brown; crown and muzzle surrounded by a golden band; two postscapular transverse annuli on each side, in contact on the median line. A yellow annulus on each inguinal region, smaller rings on humerus and tibia. "On pale specimens these markings are represented by refulgent bands which are readily destroyed or passed over; hence the imperfections in Girard's description."

Certain other characteristics of this species evident in the Bataan specimens are: skin shining smooth above and on sides, as well as on chin and anterior part of venter; tympanum distinct, its upper and posterior edges indistinctly outlined; a thickened ridge or indistinct fold runs diagonally from eye to arm insertion; posterior part of venter with some granules; part of ventral, and much of posterior surface of thigh granular; anal flap distinct, its posterior edge partly covering four large pustular tubercles which may be partially confluent; tibiotarsal articulation reaches eye; limbs folded at right angles, the heels overlap when legs are folded usually less than one millimeter; a skinfold from axilla along sides of abdomen meet in front of thigh, forming a ventral "disc"; fingers and toes much widened at tips, with adhesive pads below; first finger actually longer than second but when juxtaposed the second extends farther forward; second and fourth fingers reach forward an equal distance; greatest width of third finger disc 2.05 mm.; of first finger, 1.3 mm.; palmar tubercle large, distinct, rounded; a small indistinct tubercle at base of first finger; basal subarticular tubercles well defined, rounded; outer tubercles on third and fourth fingers smaller, less distinct.

Largest distal discs on toes (2.8 mm.) smaller than largest finger discs; inner and outer metatarsal tubercles distinct, with a suggestion of a median tarsal tubercle sometimes evident; a trace of a lateral ridge on inside edge of fingers and toes; a small tarsal ridge begins behind inner tarsal tubercle and terminates in a short more

elevated ridge midway of tarsus. In preservative lower eyelid white, with a black upper border.

Tongue, narrow, elongate, rounded behind, unnotched, free for half its length; male with two lateral vocal slits near jaw; openings of Eustachian tubes lateral equally as large as choanae, which likewise are lateral in position.

Specimens in my collection (E.H.T.-H.M.S.) from Panamá differ from the Costa Rican forms in no essential structural detail. The specimens, however, now show no trace of their former color or markings.

The figure in Steindachner (*loc. cit.*) shows markings similar to the description given by Cope.

All specimens I have encountered were roving about on the forest floor at some distance from streams or rivulets, but in a region where tiny rain pools were to be found. The presence of adhesive digital discs permit them to climb trees, but none was found in such a place.

Theodore Eaton, Copeia, 1941, pp. 93-95, gives an excellent account of the curious behavior of the males in bringing tadpoles on their backs to a small water-filled cavity in a tree. He tells of removing all tadpoles from the water hole only to find that on a later visit others had been carried to the place. These, too, were removed by him, and still others were brought by the males later.

At Bataan the specimens I observed, when disturbed, often took refuge in the numerous aerial roots of a certain palm tree where the roots entered the earth, and could not be induced to leave this shelter; nor could they be seized since the spines on the roots and their thickness prevented a hand from reaching the refugees.

The secretions from the skin of this species are highly poisonous to other frogs if they are carried together with them in a collecting bag. I did not note any effect from handling them myself.

Duméril and Bibron, *Herp. Gen.* vol. 8, pp. 653, 654, give *Hyla aurata* Maximilian zu Wied. as a questioned synonym of *Dendrobates tinctorius* Wagler. If this synonymy is correct, then the name *aurata* Girard is untenable, a matter that cannot be decided at this time.

The specimens from Bataan have the terminal digital discs as wide as the tympanum, and may differ in this point from Girard's type. Other differences might be evident if the types were compared with my specimens.

Genus *Phyllobates* Duméril and Bibron

Type of the genus: *Phyllobates bicolor* Bibron.

The original description of this genus appeared in the *Herpétologie Générale*, vol. 8, p. 637, and the single species *Phyllobates bicolor* Bibron is included.

Boulenger accepted the genus *Phyllobates*, but has included a number of forms now regarded as belonging in the Leptodactylidae. Boulenger had no direct knowledge of the genus (see *Catalogue Batrachia Ecaudata*, p. 194) and it would seem that at first the essential characters of the genus were not sensed by Cope, who described in it several species belonging to a different family. Later Cope did separate certain of these and for them erected the genera *Syrrhophus* Cope, *Hypodictyon* Cope and *Malachylodes* Cope.

Werner (1901) revised these small frogs, placing them, as certain authors have done, in the genus *Dendrobates*. He described *D. amoenus* which is definitely a *Dendrobates*.

Barbour and Noble (1920) undertook the study of the genus *Phyllobates* but overlooked or failed to discern that the species described by Schmidt (1858) *lugubris*, and *talamancae* a species described by Cope (1875) from Costa Rica, both under the generic name of *Dendrobates*, were actually members of the genus *Phyllobates*.

Dunn and Barbour (1921) described as new, *Phyllobates beatrixiae* from near Zent, Costa Rica, and redescribed *Dendrobates talamancae* Cope (from Old Harbour, Costa Rica) recognizing it as a *Phyllobates*. They recognize *Dendrobates lugubris* Schmidt (5000 to 7000 ft. between Bocas del Toro and Volcán Chiriqui, Panamá) and *Dendrobates truncatus* Cope (Panamá) as belonging to the genus *Phyllobates*.

Later Dunn (1924) with more materials at hand recognizes *Phyllobates talamancae* (Cope), and *Phyllobates latinasus* (Cope); but the species *Phyllobates beatrixiae* described in the previous paper is placed in the synonymy of *Phyllobates lugubris* (Schmidt), and he states that the previous redescription of *talamancae* was based on a male and female belonging to different species, only one of which was *talamancae*. Localities given for *latinasus* in Costa Rica are Santa Cecilia, for *talamancae*, Santa Cecilia and Suretka; and for *lugubris*, Talamanca valley and Zent.

In 1931 he describes as new a small species *Phyllobates flotator* the type locality being Barro Colorado Island. One (paratype?)

specimen is listed from Suretka, Costa Rica. The suggestion is made that *Dendrobates tinctorius vittatus* Cope from Buenos Aires belongs in *Phylllobates lugubris*. In 1933 he announced the intergradation of *Phylllobates flotator* and *Phylllobates nubicola*; and *flotator* is reduced to subspecific status, as *Phylllobates nubicola flotator* Dunn. In 1940 he refers *Phylllobates lugubris* to the genus *Dendrobates*.

Four species of the genus are represented in the fauna of Costa Rica.

KEY TO COSTA RICAN SPECIES OF PHYLLOBATES

1. Third finger of male swollen; a lateral streak starting from the middle of the black lateral band in groin and reaching eye; male with white throat; snout-to-vent 17 mm *nubicola flotator*
Third finger of male not swollen; not so marked 2
2. Venter black in both sexes with or without some lighter reticulation; black above; cream or yellowish line from tip of snout, across eyelid to rump or groin; venter and limbs with some light markings or reticulations; a white stripe from below eye to arm insertion. (23 mm.) *lugubris*
Venter yellow or whitish; chin of males may be black 3
3. Black or dark brown above, the venter, (save on chin and breast of males which are blackish), whitish or yellowish cream; a yellowish or cream dorsolateral line; a lateral dark stripe present. (23 mm.) *talamancae*
Brown above with a black streak from eye to eye around snout; a white streak in front of thigh on a broad black lateral stripe; upper lip white; legs pale with dark bars of brown on both leg and foot. (20 mm.) *pratti*

Phylllobates lugubris (Schmidt)

Figure 10

Dendrobates lugubris Schmidt, Sitzungsber. k. Akad. Wiss. math.-natur. Cl. Wien, 1857, pp. 12-13 (type locality not indicated); and Denkschr. k. Akad. Wiss. math.-natur. Wien, Bd. 14, pt. 2, 1857 (1858) p. 2, fig. 14 (type locality, road between "Boca del Toro und dem Vulcan Chiriqui . . . zwischen 5000 und 7000 (ft.)", V. Warszewicz coll.); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 1882, p. 145.

Hylaplesia lugubris Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 88 (no specimens).

Hylaplesia tinctoria (part.) Günther, Catalogue of the Batrachia Salientia in the Collection of the British Museum, 1858 (Feb. 12, 1859), p. 125 (Var. A.); Biologia Centrali-Americana; Reptilia and Batrachia, Feb., 1900, p. 207.

Phylllobates beatriciae Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Aug. 17, 1921, p. 159 (part.) (Victoria farm near Zent, not far from Puerto Limón, Costa Rica, Dunn coll.); Occ. Papers Mus. Zool. Univ. Michigan No. 151, July 1, 1924, p. 5 (places the species in the synonymy of *lugubris*).

Phylllobates talamancae (part.) Barbour and Dunn, Biol. Soc. Washington, vol. 34, Aug. 17, 1921, p. 159, 160.

- Phyllobates lugubris* (part.) Dunn, Occ. Papers Mus. Zool. Univ. Michigan No. 121, July 1, 1924, p. 5, 7, 10 (confused with *Phyllobates flotator* [fide Dunn], data given on tadpole); Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 390-392.
- D[endrobates] lugubris* Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, p. 110 (apparently considers *lugubris* Schmidt a species of the genus *Dendrobates*).

Diagnosis: This small species (23 mm.) is characterized by an almost entirely black coloration above and below; dorsolateral light stripes from rump pass across eyelid to snout tip; no lateral stripe; venter and limbs with elongate irregular light markings; a white stripe from arm insertion to below eye; digital discs have a pair of small thickened pads on their dorsal surface; (in life the black of belly may have a greenish color, and the throat and legs may have a yellowish or pinkish wash).

Description of species: (from K.U.M.N.H. No. 24908, Morehouse Finca, ♀). Head width (7.5 mm.) less than head length (8.7 mm.); eye large, its length (3 mm.) slightly shorter than snout (3.3 mm.); tip of snout rounded, truncate; distance from nostril to eye slightly greater than distance to middle notch of upper lip; distance between nostrils equals eye length; upper eyelid width in interorbital width 1.2 times; lower part of tympanum distinct, its diameter twice the eye length; choanae small, concealed under shelf of maxilla when seen from below; no vomerine teeth; maxillary teeth present; tongue two and one-half times as long as wide, free for nearly half its length; (male with vocal slits).

Skin of back with minute pustules or granules visible under lens; sides, venter, chin, limbs (generally), smooth; (area below anal opening may be slightly areolate or granular).

Arm slender, elongate, the digits with small terminal pads, subequal in size, the first slightly smaller, the third slightly larger than others; subarticular tubercles moderately distinct, not elevated; a large rounded median palmar tubercle; a small inner tubercle at base of first finger; first finger metacarpals not bound together with the other metacarpals; first finger a little longer than second; no trace of web.

Leg rather long, the tibiotarsal articulation to middle of eye; no trace of a web between digits; subarticular tubercles indistinct; a larger inner and smaller outer metatarsal tubercle; a small indistinct tarsal tubercle or ridge (sometimes tending to reach to the inner metatarsal tubercle; heels touch when limbs are folded at right angles to body; pads on toes larger than those on fingers, those of three middle toes largest.

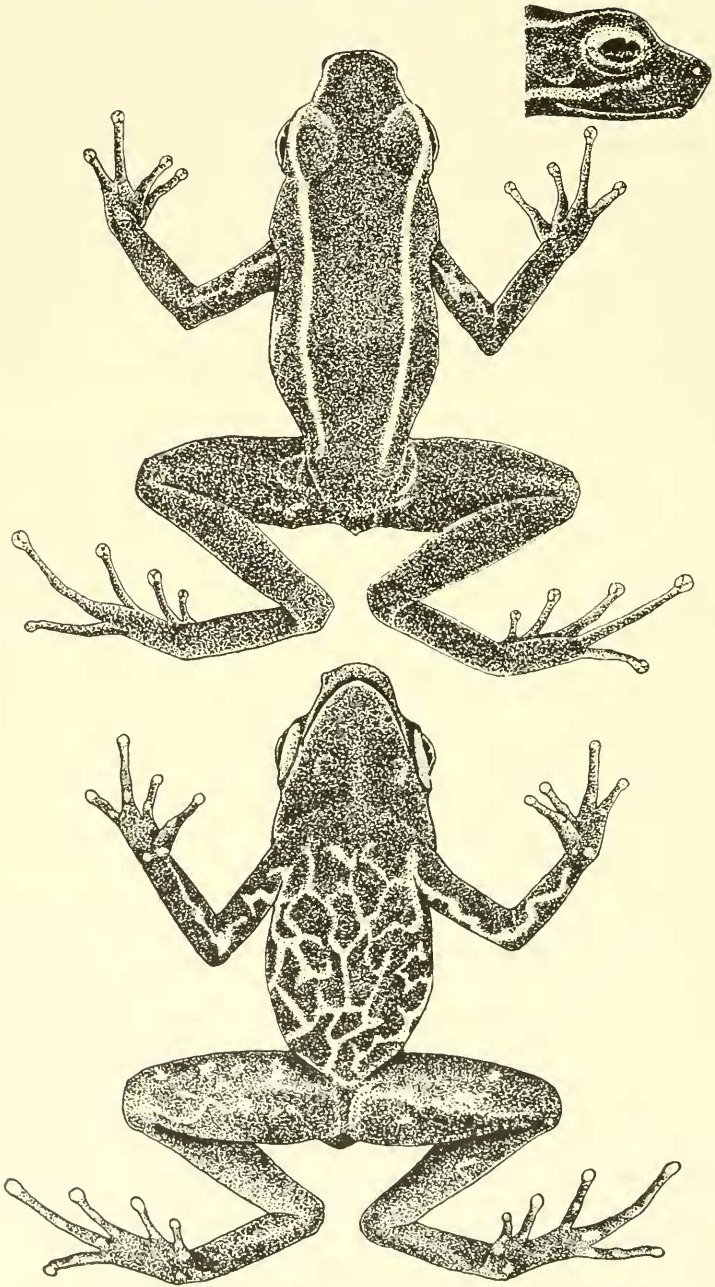


FIG. 10. *Phyllobates lugubris* (Schmidt), from K.U.M.N.H. No. 24908; Morehouse Finca, 5 mi. southwest Turrialba; actual snout-to-vent length, 22.5 mm.

Measurements in mm.: Snout to vent, 22.5; width of head, 7.5; length of head, 8.7; head to arm insertion, 8.8; arm and hand, 17; leg, 31; tibia, 10.8; foot and tarsus, 14.4.

Color.: General color black with yellowish stripe extending from the rump, across eyelid and around tip of snout; a narrow white line beginning under middle of eye runs back and onto dorsal surface of arm; chin and throat intense black; abdomen and sides and under side of limbs black, with white or silvery vermiform markings or spots; anterior and ventral face of femur, tibia and tarsus with similar white marks; a light mark across dorsal surface of thigh at base; toes and fingers of a lighter shade than body; posterior surface of thighs black with minute white punctations.

Remarks: The species was taken on the banks of the Río Reventazón on the I.A.I.A. farm near Turrialba, Costa Rica (4 spec.); on the Morehouse Finca, 4 mi. S Turrialba, along a small rivulet (1 spec.); and at Los Diamantes, 1 mi. S Guápiles, Costa Rica, along the banks of a small river (3 spec.). The preserved material shows complete similarity in characters although in life one of the Turrialba specimens was somewhat greenish on the venter. All were black above with stripes present on the back. One specimen, taken at Turrialba (a male, R.C.T. No. 227) displayed a yellowish area on the throat, covering the vocal sac, while the belly itself was yellow-green. The cream line on the lip and the dorsolateral lines were the same color as those in the female specimen. A wash of pink was present on the dorsal surface of the thigh. This pink color disappears quickly in alcohol. The vocal sac has two lateral, longitudinal, external folds. The internal vocal slits are ample.

Phyllobates pratti Boulenger

Phyllobates pratti Boulenger, Ann. Mag. Nat. Hist., ser. 7, vol. 3, Apr. 1899, pl. 11, fig. 3 (type locality, Santa Innes, N. of Medellín, Colombia, A. E. Pratt, coll.); Barbour and Noble, (*part.*), Bull. Mus. Comp. Zool. Harvard Col., vol. 63, no. 8, Jan. 1920, pp. 398, 399, 400, 401 (states that Boulenger considers *P. pratti* a synonym of *latinus*.).

Phyllobates latinus Dunn, (*part.*), Occ. Papers Mus. Zool. Univ. Michigan, No. 151, July 1924, pp. 5, 6, 7, 9, 10 (Santa Cecilia, Costa Rica, and Panamá localities); Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 389, 391 ("What I called *talamancae* in 1921 was based on one specimen of *talamancae* and one of *latinus*, and I properly segregated *latinus* in 1924, I included the present *flotator* under *talamancae*." After listing specimens of *latinus* from localities in Panamá and Costa Rica, Dunn states: "The specimens seen are all the same species, and different from any other seen but close to *kingsburyi*. Whether they are Cope's species is perhaps questionable. *Latinus* was described as 30 mm. long, which agrees with *kingsburyi*, but not with what I am calling *latinus*, of which I have seen none over 21 mm. Otherwise the description agrees better with what I am calling *latinus* than with what I am calling *kingsburyi*.").

Diagnosis: A diminutive *Phyllobates* without webbing on fingers or toes; discs well-developed smaller than the tympanum; heel reaches to eye; skin smooth, finely shagreened on back.

Description of species: "Snout rounded, moderately prominent, not quite so long as the diameter of the orbit; loreal region vertical; nostril a little nearer to the tip of the snout than the eye; interorbital space broader than the upper eyelid; tympanum rather indistinct, hardly half the diameter of the eye. Fingers moderate, first extending slightly beyond second; toes moderate, free; disks well developed; smaller than the tympanum; two small metatarsal tubercles, inner oval, outer rounded; a small oblique tubercle or ridge in the middle of the inner side of the tarsus. The tibiotarsal articulation reaches the eye. Skin smooth, finely shagreened on the back. Brown above; a black streak from eye to eye round the snout; upper lip white; broad black lateral stripe and a white streak in front of the insertion of the thigh; limbs pale, with a dark brown streak on the thigh and some dark brown bars on the leg and foot; lower parts white. From snout to vent 20 mm.

Remarks: Dunn has referred this form to *Phyllobates latinasus*^o Cope from the Truando region, Colombia. Unfortunately the type of Cope's species is lost, but in Cope's opinion the form was different enough to warrant a new generic designation.

Description of species, Phyllobates latinasus (Cope): (From type description.) Head elongate; front plane transversely, gently arched longitudinally, a little wider than from orbit to end of muzzle. The latter is prominent, broad, and concavely truncate; external nares lateral. Loreal regions plane. Internal nares widely separated. Tympanum round, equal one-fourth extent of orbit, whose diameter equals length of muzzle from orbit. A slight web between outer fingers, of which the second is shorter than the inner or first; one large carpal tubercle on metacarpus of thumb. A dermal fold on the tarsus. Two metatarsal tubercles. The carpus reaches the end of the muzzle, and the heel the anterior border of the orbit. Length of head and body 3" (three centimeters).

"Above brown; a black band across end of muzzle and loreal region, through eye to groin; pale-bordered above on the muzzle, and interrupted by an oblique white line from the femur. Femur

^o *Phyllobates latinasus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1863, pp. 48-49 (type locality, Truando region, New Granada).

Colostethus latinasus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 130 (type of new genus *Colostethus*); Journ. Acad. Nat. Sci. Philadelphia, vol. 6, pt. 2, Sept. 1867, p. 197 (new family *Colostethidae*).

[*Phyllobates*] *latinasus* Barbour and Noble, Bull. Mus. Comp. Zool. Harvard Col., vol. 63, no. 8, Jan. 1920, pp. 398, 399, (*part.*).

dark posteriorly, tibia cross-banded; (color of limbs not well preserved). Beneath pale, immaculate." The type is from "Truando region, New Granada."

Remarks: Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 130, created the genus *Colostethus* for the species *Phyllobates latinasus*. It was characterized by the absence of a manubrium; membranous xiphisternum; digits free with dilations; external metatarsals bound; no vomerine teeth; prefrontals widely separated by the largely produced bony superior ethmoid plate. Maxillary teeth present; distal phalanges with terminal transverse limb.

Still later, (Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, 1867, p. 197) he established the family *Colostethidae* for this same species, adding another pertinent character: no metatarsal tubercles. Barbour and Noble (Bull. Mus. Comp. Zool. Harvard College, vol. 63, no. 8, Jan. 1920) place *Colostethus* as a synonym of *Phyllobates* stating "There remains another genus which should be referred to the synonymy of *Phyllobates*. *Colostethus*, known only from the type specimen of *C. latinasus*, was described by Cope as lacking the omosternum. The type specimen cannot be found in either the U. S. National Museum or the Academy of Natural Sciences of Philadelphia. Specimens very similar to *C. latinasus* but possessing an omosternum have been found in Ecuador and Colombia. . . . Boulenger has recently advised the senior author by letter that he considers his *Phyllobates pratti* referable to *C. latinasus*. Boulenger evidently considers that Cope overlooked the omosternum, a very probable oversight, in view of the smallness of the type of specimen."

Since the type of Cope's species cannot be found there is no absolute certainty that the species occurring in Costa Rica should have this name.

Phyllobates talamancae (Cope)

Dendrobates talamancae Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 102, pl. 23, fig. 6 (type locality Old Harbor on the eastern coast of Costa Rica, Gabb, Coll.). (The village of Old Harbor, said to have been 20 miles south of Port Limón, is not now in existence.)

Hylaplesia talamancae Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études des Batraciens de l'Amérique Centrale, livr. 2, 1882, pp. 88-89 (data from Cope); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 1882, p. 145; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb., 1900, p. 208.

Phyllobates talamancae (part.) Dunn, Proc. Biol. Soc. Washington, 1921, pp. 159-160 (mixed *talamancae* and *latinasus*, *vide* Dunn); Occ. Papers Mus. Zool. Univ. Michigan, No. 151, July 1, 1924, pp. 2, 4, 5, 6, 7, 9, 10, 11 (confuses *talamancae* and *flotator*, *vide* Dunn).

Phyllobates talamancae Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Apr. 18, 1931, pp. 389, 390 (reported from Suretka and Santa Cecilia, Costa Rica; Gatún, Panamá); *ibid.*, Oct. 10, 1931, pp. 412, 419.

Diagnosis: This small inconspicuous species may be characterized as follows: Small frogs, maximum size about 23 mm., lacking vomerine teeth, but with maxillary and premaxillary teeth present; tips of digits dilated, with paired, thickened pads on their dorsal surface. First finger distinctly longer than second; blackish brown above with a yellowish (in life) stripe from groin to eye; a lateral dark stripe bordered below by a light stripe that reaches along edge of lip to tip of snout.

Description of species: (K.U.M.N.H. No. 24904). Head length (8.1 mm.) greater than width (7.6 mm.); loreal region nearly vertical; eye large, its length (2.8 mm.) equals length of snout; area about lateral nostril slightly swollen making the terminal width of snout slightly greater than part immediately following nostrils; interorbital width equals eye length, one and four fifths width of an eyelid; lower half of tympanum more or less visible, its diameter in eye length 1.75 times; choanae hidden by maxillary shelf when palate is seen from below; maxillary and premaxillary teeth present; vomerine teeth absent; tongue elongate, narrow, widened somewhat posteriorly, free for half its length.

Arm moderately long; metacarpal of first finger not bound together with other metacarpals; the first finger distinctly longer than second; discs at tips rather large, that of first finger nearly as large as those of other fingers; subarticular tubercles prominent, large; a large rounded median palmar tubercle; a small, somewhat elongate outer tubercle; leg moderately long, tibiotarsal articulation reaches to eye; an elongate elevated inner metatarsal tubercle, and a smaller elevated outer; a small inner tarsal tubercle or ridge somewhat in advance of the middle of the tarsus; toe discs larger than finger discs, that on fourth toe largest; no supernumerary tubercles; skin of back and sides, limbs and venter generally smooth; area about anal opening somewhat pustular.

Color: Dark blackish brown above with dorsolateral yellow lines from groin to around eyelid; below this a broad black stripe reaching snout tip; this bordered below by a narrow whitish or yellow line that borders all of upper lip; below this line on sides some indistinct darker marbling; belly and chin uniform flesh white; arms lightly pigmented, leg with the front of femur light, and a small line from groin joining it to form a hook-shaped mark; lighter and darker indefinite marking on tibia, tarsus, and foot. Under-side of foot a little darker than underside of hand.

Measurements in mm.: Snout to vent, 23; length of head, 8.1; width of head, 7.6; length of eye, 3.2; length of snout, 3.4; arm, 15; hand, 4.5; leg, 32; tibia, 10.2; foot and tarsus, 13.4.

Remarks: The males of this species are of nearly the same size as females (18-20 mm.), and there is more black color below the lateral light line. The throat and chin are blackish and there are two longitudinally folded areas on chin, marking the vocal sac. The vocal slits in mouth are elongate, and the sac itself is at least partially divided, seemingly extending on to the breast and back as far on sides as arm insertion. One male displays much clouding on the venter. Certain of the specimens have lateral abdominal folds suggestive of a ventral abdominal "disc."

The following notes were made on certain specimens in life.

No. 24902 ♀. "Chin yellowish white; venter whitish flesh; thighs with a salmon wash; blackish on back, with gray to bronzy stripes; lips yellowish white; groin and an area on back of thighs pinkish; arms and legs somewhat olive above, with some darker spots."

A male, R.C.T. No. 364. "Coal black on chin, throat and breast; salmon wash on underside of thighs; a few minute whitish dots in anal region."

Twelve specimens are in the collection from the Morehouse Finca, four miles south of Turrialba, and 32 specimens from the Río Reventazón near the Inter-American Agricultural Farm at Turrialba.

Phyllobates nubicola flotator Dunn

Phyllobates flotator Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 389-390, 392 (type locality Barro Colorado Island, Canal Zone, Panamá. Specimens listed from Suretka C.R. and other Panamanian localities); *ibid.* vol. 5, Oct. 10, 1931, pp. 412-419.

Phyllobates nubicola flotator Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 8, June 7, 1933, p. 74.

Diagnosis: A *Phyllobates* with black and white coloration; a lateral streak starting from middle of black lateral band in groin and reaching eye; male with white throat; male with swollen third finger; tadpole with no labial teeth and much produced lower lip.

Description of species: (from the type description.) Adult male; loreal region vertical, slightly concave; interorbital space broader than upper eyelid; tympanum indistinct, $\frac{1}{3}$ size of eye; disks well developed, smaller than tympanum, third finger swollen, as wide as disk, disk of toe I half size of toe II; disk of toe V half size of disk of toe IV; top of toe I misses penultimate phalanx of toe II; tip of toe II reaches antepenultimate phalanx of toe III; tip of toe III reaches antepenultimate phalanx of toe IV; toe IV $2\frac{1}{2}$ phalanges beyond toe V; tip of toe V just past penultimate phalanx of toe III;

two metatarsal tubercles; one tarsal tubercle; heel barely to eye; skin finely granular; gray above; white below; sides black; light line from groin to eye obliquely through black; upper lip white; dark line on anterior edge of thigh; dark line on dorsal surface of thigh running into another dark line on posterior edge of thigh at knee, "anvil-shaped marking"; dark anal triangle; legs not barred; head to snout 17 mm.

Variation: A female from the same locality is similar save for the third finger not being swollen. A specimen from Cana in Darien has slightly longer third and fifth toes.

FAMILY LEPTODACTYLIDAE Berg

Leptodactylidae Berg, Anal. Mus. Nac. Buenos Aires, vol. 5, 1896, p. 161.

This family has representatives of four genera in Costa Rica. These are *Eupemphix*, *Eleutherodactylus*, *Microbatrachylus* and *Leptodactylus*. These genera may be distinguished by the following synopsis.

KEY TO COSTA RICAN GENERA OF LEPTODACTYLIDAE

1. Small toadlike animals without teeth on vomer or maxillary

<i>Eupemphix</i>	
Variable forms with maxillary teeth; vomerine teeth present or absent	2
2. Diminutive species with a large inguinal gland present; vomerine teeth

<i>Microbatrachylus</i>	
Larger species with vomerine teeth usually present, inguinal gland lacking or very small	3
3. Mesosternum forming a bony style; vomerine teeth in elongated transverse series

<i>Leptodactylus</i>	
Mesosternum cartilaginous, usually with a double, arrow-shaped posterior termination; vomerine teeth not in strongly transverse series	<i>Eleutherodactylus</i>

Genus LEPTODACTYLUS Fitzinger

Leptodactylus Fitzinger, Neue Classification der Reptilien . . ., 1826, pp. 38, 64.

Four species are recognized in the Costa Rican Fauna, one of which is very large, reaching a size exceeded only by that of the large *Bufo marinus*. The forms may be recognized by the following key. *Leptodactylus labialis* has been reported for Panamá. I have seen no Costa Rican specimens.

KEY TO COSTA RICAN SPECIES OF LEPTODACTYLUS

1. Heel not reaching to middle of eye; males with two horny spines on first finger; toadlike forms

2

- Heel reaching front of eye or between eye and tip of snout; no horny spines on first finger of males; froglike forms

3

2. Very large toadlike species; a pair of horny excrescences on breast in males; heel reaching middle of eye; dorsolateral folds present; canthus rostralis moderately distinct; toes without trace of web but with traces of fringes; length to 160 mm. or more; skin practically smooth *pentadactylus dengleri*
 Smaller toadlike species less than 50 mm. in length; no horny excrescences on breast; heel reaches to tympanum; skin with rows of minute horny tubercles, toes with small web remnants and a trace of fringes on sides of digits *melanonotus*
3. Two glandular ridges on each side of vertebral line; nostril nearer eye than median tip of snout; vomerine teeth in arched series behind choanae from near median line to level of outer edge of choanae; interorbital width greater than eyelid; heel to front of eye; gray with four more or less distinct black, longitudinal lines; tibia with a wide longitudinal band; 37 mm. . . . *quadrivittatus*
 Glandular fold from eye to groin, and one from eye to shoulder; nostril nearer tip of snout than eye; interorbital space equals upper eyelid; heel to midway between eye and tip of snout; pale brown, glandular folds black-edged; a dark brown triangular blotch on the back of head; lacking four dorsal lines; 43 mm. *maculilabris*

Leptodactylus pentadactylus dengleri Melin

Figure 11

Rana pentadactyla Laurenti, Specimen medicum, exhibens Synopsis Reptilium emendatum cum Experimentis circa Venena et Antidota Reptilium Austriacorum Viennae, 1768, p. 32 (type locality—the species is based on a figure of *Rana maxima Virginiana* Seba, Thesaurus, vol. 1, pl. 75, fig. 1, a species of unknown provenance).

Cystignathus pentadactylus Peters, Monatsb. Akad. Wiss. Berlin, 1872, p. 198. (Good bibliography).

Leptodactylus pentadactylus Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, pp. 241-242. Günther, Biol. Cent. Amer. Rept. Batr., 1900, p. 212; Barbour, Mem. Mus. Harvard Col., vol. 41, 1914, p. 251; Lutz, Mem. Inst. Oswaldo Cruz, vol. 19, 1926, pp. 143-144, pl. 30, figs. 1, 2, 5, 6; pl. 34, figs. 2-3; pl. 36, figs. 1-2; Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, pp. 410, 418; and Dunn, in Barbour, Ann. Rep. Barro Colorado Island, Biol. Lab. Panama, Canal Zone, 1931, p. ? (Barro Colorado Island); Schmidt, Smithsonian Misc. Coll., vol. 89, No. 1, 1933, p. 4 (Porto Bello, Canal Zone); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 8, 1933, p. 64.

Leptodactylus pentadactylus dengleri Melin,^o Medd. Göteborgs Mus. Zool., ser. B. Band 1, No. 4, 1941, pp. 51-52, fig. 28.

Leptodactylus pentadactylus pentadactylus Andersson, Ark. för Zool., Band 37 A. no. 2, 1945, pp. 47-52, fig. 16 (Costa Rica, Nicaragua, and Ecuador).

^o Melin presumably has used the description, given by Lutz (*loc. cit.*) for his concept of the type form of the species. The figures given by Doctor Lutz (*loc. cit.*), show narrow-headed, and broad-headed types, and considerable variation in coloration is indicated. The type locality is not fixed, and there is no certainty that Doctor Lutz took into consideration a probable type locality other than a very general one. From data given by Melin, it is probable that the form occurring in Costa Rica is closer to *L. p. dengleri* Melin than to the typical form. Whether a series would show subspecific differences from *dengleri* is a fact that cannot be decided with the material at hand. Andersson (Arkiv för Zoologi, Band 37A, no. 2, 1945) does not take into account the form described by Melin, but for specimens. I presume to be the form described by Melin, he uses the name *p. pentadactylus* and another form is described as *Leptodactylus pentadactylus rubidoides*.

The synonymy must of necessity refer in part to other subspecies; however, I cannot attempt to distinguish those that refer only to this subspecies.

Melin has recently (1941) described a subspecific form of the species as *Leptodactylus pentadactylus dengleri*. Comparison of Costa Rican specimens show that they agree best with that form described from Rogue, Peru, and they are here treated under this name.

Diagnosis: A very large toadlike form, the larger males measuring 130 mm. and the large females 135-160 mm.; heavy dorso-lateral folds; a supratympanic fold completely separated from the dorsolateral fold extending diagonally to above the arm; males with arms greatly thickened; pollex well developed, protruding, bearing a horny cap and a lateral spine; a pair of horny excrescences on breast of males; a strongly developed preinguinal gland; lateral glands absent or less developed in the female. Vomerine teeth in arched series between choanae.

Description of species: Head broad, its width (62 mm.) greater than length (49 mm.); canthus moderately distinct, rounded, curving forward to the nostril; loreal region only slightly concave, sloping obliquely to lip; tympanum distinct (9.5 x 8 mm.) its greatest diameter distinctly less than length of eye (14.5 mm.); eye greater than its distance from nostril (13 mm.); width of an eyelid (13 mm.) greater than interorbital width (12 mm.); tongue large, oval, notched behind; vomerine teeth in two curving series between and partly behind the irregularly transverse choanae; vocal slits short; the sac not ample.

Arm short; greatly thickened (♂) (or slender in ♀); digits with blunt somewhat rounded tips, not or but slightly dilated; first finger much longer than second; pollex strongly developed, terminating in a free point 5 mm. in length, bearing a terminal cap of black horn for nearly its entire length; a lateral spine also present; first and third fingers nearly equal, the fourth longer than second; subarticular tubercles distinct; a large prominent metacarpal tubercle at base of pollex; palmar tubercle large, less distinct, partly bifid; heel reaching to middle of eye; toes without webs, but with traces of lateral fringes; a small inner metatarsal tubercle, outer tubercle still smaller but distinct; an inner tarsal fold; fourth toe distinctly thicker and heavier than other toes.

Skin smooth; a dorsolateral fold begins behind eye and extends to side of rump, sometimes broken posteriorly; a supratympanic fold begins at corner of eye and passes diagonally to a point above arm; a large inguinal gland, with two or three other lateral glandular areas present; usually glandular folds in region of vent and side

of rump. A pair of heavy, horny excrescences on breast, seemingly developed from small pectoral glands, and may be shed, and formed again (at least they are absent in some males and present in others); minute pearl-tipped pustules or tubercles cover greater part of the chin in males and are scattered over breast and postpectoral regions; posterior part of the ventral side of thigh, as well as lower part of the posterior face with minute granules; vent high with a small,



FIG. 11. *Leptodactylus pentadactylus dengleri* Melin. K.U.M.N.H. No. 25716; Los Diamantes, Costa Rica; snout-to-vent length, 136 mm.

seemingly glandular anal flap; pair of glands lateral to vent; venter and chin of females smooth.

Color: Grayish brown, with or without a dorsal pattern of slightly darker brown transverse markings beginning on the snout; a brown line follows the dorsolateral fold and a black one passes from nostril to eye, continuing behind eye along the supratympanic fold; one or two black dashlike spots above arm; lips with four dark brown spots, the median anterior pair nearly black, reaching to near nostril; arm not conspicuously barred; legs with numerous blackish bars and spots; venter dirty gray, mottled darker; throat of males dark.

Measurements in mm. of K.U.M.N.H. No. 25717, Turrialba, Costa Rica: Snout to vent, 143; width of head, 62; length of head, 49; length of eye, 14.5; length of snout, 19; arm, 75; hand, 35; leg, 195; tibia, 70; foot and tarsus, 101.

Remarks: These great frogs are often found in excavations below rotting logs, presumably made by some other animal. The eggs are laid in great masses of foam in moist spots or at the edge of small rain pools. One such mass filled a four-liter bucket with a little left over. The powerful booming voice carries a distance of more than a kilometer under ordinary circumstances.

The skin secretions are irritating to the soft skin between ones' fingers, and are painful if they enter scratches or small cuts in the skin.

Leptodactylus melanonotus (Hallowell)

Figure 12

Cystignathus melanonotus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 485 (type locality Nicaragua); Cope, Proc. Amer. Philos. Soc. vol. 18, p. 269.

Leptodactylus caliginosus (part) Nieden, Das Tierreich, Lief. 46; Anura I, 1923, pp. 491-492.

Leptodactylus melanonotus Dunn, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, 1931, p. 406 (western Panamá and Darien); *ibid.* vol. 8, 1933, p. 67, El valle de Anton, Panama; Proc. Acad. Nat. Sci. Philadelphia vol. 92, 1940, p. 107.

Diagnosis: One of the smaller species of the genus (less than 50 mm.) with two horny spines on outer edge of the first finger, lacking horny excrescences on breast but often with horny excretions on surface of glands, on side of neck in front of arm insertion, on sides behind arm insertion and on the outer posterior surfaces of thighs; heel to tympanum; skin with irregular rows of minute horny tubercles; small web remnant and at least traces of fringes on sides of digits.

The original description of the type, a presumed young specimen from Nicaragua, is brief, omitting most of the essential diagnostic characters. It is given here in full.

Cystignathus melanonotus nob.

Special characteristics: "Color black above, with black spots; a black subround spot between the eyes; under parts white, minutely mottled and spotted with brown; body and extremities slender.

Description: "Head of moderate size, eyes not remarkably prominent, tympanum well developed, tongue obcordate, not notched posteriorly; palatine teeth in two transverse rows; the anterior margin on a line with the posterior margin of the posterior nares; color as stated in the specific character.

Dimensions: "Length of head 4 lines; greatest breadth 3; length of head and body 9 lines; length of anterior extremities 6 lines; of posterior, 1 inch; of thigh 3 lines; of leg 4; of tarsus 2 lines; of foot to extremity of longest toe $4\frac{1}{2}$ lines.

Habitat: "Nicaragua. One specimen; perhaps the young of a larger animal."

Description: (From K.U.M.N.H. No. 28187, La Suiza, $5\frac{1}{2}$ mi. SW Turrialba, Costa Rica, July 15, 1947). Body rather slender, the snout-to-vent length 40 mm.; head narrow, its width (16 mm.) less than length of head (19 mm.); canthus wanting with a very slight depression in loreal region; nostril equidistant from eye and median point on upper lip; width of an upper eyelid equal to narrowest interorbital distance; a strong thickened fold from eye, covers upper edge of tympanum, behind which it angles downward to above arm insertion where it terminates in a glandular area; this separated from another glandular area by a groove; tympanum longitudinally oval, its length 2 mm. its height 1.6 mm., separated from the eye by a distance of 2.8 mm. equal to the distance between nostrils; length of eye opening (4.2 mm.) less than median length of snout (4.6 mm.); choanae small, the distance between them (3.1 mm.) nearly 6 times the diameter of a choana; vomerine tooth fasciculi slightly diagonal, distinctly behind level of choanae and not reaching laterally to their inner level; tongue slightly notched behind, wider and thicker posteriorly than anteriorly, free for nearly a fifth of its length; ostia pharyngea nearly double the area of choana; (males with vocal sacs?).

Arm short the wrist not reaching beyond snout; first finger equal or minutely longer than second; fingers unwebbed, but a distinct fringe or sharp ridge on inner side of the second and third fingers;



FIG. 12. *Leptodactylus melanonotus* (Hallowell); K.U.M.N.H. No. 28187 ♀; La Suiza 5½ mi. SW Turrialba, Costa Rica; Snout-to-vent, 41 mm.

slight subterminal swellings, the tips narrower than digits; a strongly elevated inner metacarpal tubercle; a prominent, partly bifid outer palmar tubercle; an indistinct tubercular ridge on under side of arm. Some pustular tubercles below elbow; subarticular tubercles four; indistinct supernumerary tubercles on palm; (male with two spines on thumb; vocal slits present).

Leg short, heels not touching when legs are folded at right angles to body; limb brought forward, tibiotarsal articulation touches

back edge of tympanum; a small web remnant between toes, with fringes varying in width, extending to near tips of toes; a strong elongate inner metatarsal tubercle with a free rounded tip anteriorly; a small prominent outer tubercle; inner metatarsal fold well defined, running back somewhat diagonally but not reaching heel; no outer fold; subarticular tubercles rather prominent; few or no distinct supernumerary tubercles on sole.

An indistinct dorsolateral fold; skin of dorsum covered with minute tubercles intermingled with slightly larger tubercles, many with brown, horny tips, the tubercles not in distinct rows; sides with one or two rows of somewhat larger tubercles; area on rump, dorsal surface of thighs, tibia and tarsus with somewhat larger tubercles, those on lower (anterior) face of tibia in longitudinal rows, while the others are in diagonal rows; chin and venter smooth, with deep brown glandular areas on sides of neck, on anterior part of venter extending slightly up on side behind axilla, and on posterior part of venter. A large gland on outer part of the posterior face of thigh, and one on posterior part of tibia.

Color: Brownish with a light-edged brown mark beginning midway between, and on eyelids, running back to the sacral region; an indistinct darker line from eye to groin becoming double posteriorly; tympanum dark; small brown spots on rump and on dorsal surface of legs; indistinct light flecks on outer part of posterior face of femur with two somewhat lighter regions below and lateral to vent; no dark ventral spots save for the horn brown of glandular areas.

Measurements in mm.: Snout to vent, 40; width of head, 16; length of head, 19; arm, 23; leg, 54; tibia, 16; tarsus and foot, 28.

Remarks: This species is believed to extend from Mexico to South America. There is some doubt that all the specimens referred in the literature to *melanonotus* actually belong to Hallowell's species. I have specimens, belonging to the form described, from Turrialba, and Bataan. What I believed to be this species was heard at Moravia but none was captured.

This species can be heard calling during the daytime as well as at night, and choruses occur day after day in swampy areas even when there is no evidence that the breeding season is on.

Leptodactylus quadrivittatus Cope

Leptodactylus quadrivittatus Cope, Proc. Amer. Philos. Soc., vol. 31, 1894, p. 339 (type locality, Buenos Aires, Costa Rica); Nieden, Das Tierreich, Lief. 46; Anura I, 1923, p. 477; Dunn, in Barbour, Ann. Rep. Barro Colorado Island. Biol. Lab. Panamá Canal Zone, 1931, p. ? ("Rio Tucumen");

Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, pp. 410, 418;
Schmidt, Smithsonian Misc. Coll., vol. 89, 1933, No. 1, p. 5 (Panamá.)
Leptodactylus poecilochilus (part.) Dunn, Proc. Acad. Nat. Sci. Philadelphia,
vol. 92, 1940, pp. 106-107.

Diagnosis: Form slender lanceolate; nostril nearer eye than the median point on upper lip; heel to front of eye; two glandular ridges on each side of the vertebral line; vomerine teeth in arched series extending to level of outer edge of choana, and closely approximated to the median line; tympanum oval, its long diameter equals two thirds length of eye.

Description of species: Body lanceolate; head slender, the muzzle narrow and prominent; canthus lacking; nostril nearer eye than tip of snout, but separated from eye by a distance greater than length of eye; tympanum vertically oval, its greatest diameter two thirds diameter of the eye; interorbital distance greater than an eyelid; some glandular warts about scapular region. Choanae large, about as long as the ostia pharyngea; vomerine teeth behind choanae in two arched series that extend outward to outer level of choanae, narrowly separated mesially; tongue forming a wide longitudinal oval, openly notched behind.

Arm moderate, the leg relatively short, the heel reaching only to the anterior edge of eye; tips of digits not widened, the subarticular tubercles well developed; a distinct oval inner metatarsal tubercle.

Skin smooth with two stout glandular ridges running along back on either side of the median line; a discoidal abdominal fold.

"The ground color above and on the sides is gray, which is marked above with four longitudinal black bands. The two median of these are wider and commence at the end of the muzzle, and extend to the extremity of the urostyle. They expand above and over the eyelids. The lateral bands commence narrow at the orbits, and widen on the sides, extending to the groin. The median dorsal band of the ground color is paler than the rest of the ground, and has a pinkish tinge, which is probably more distinct in life judging from traces of pink near the orbit. The side of the head is black to and including the tympanic disc, excepting a pale stripe which passes below the eye to the lower border of the tympanic disc. It is crossed by two or three black lines which descend from the eye to the black lip. A pale crescent in front of tympanic disc. A pale line extends upwards and forwards from the groin on the side. The limbs are all cross-banded, except the tibia whose upper surface displays an irregular wide longitudinal band, which is a marked peculiarity. Posterior face of femur bounded below by a

pale line, which is bordered above by a brown band. Tibia unicolor, foot brown, below." Data from type description.

Measurements in mm.: Snout to vent, 37; snout to posterior edge of tympanum, 14; width of head, 15; arm from axilla, 18; hand, 8; leg, 65; foot, 31; tarsus, 12.

Remarks: This species is presumably a lowland form. I have not recognized the species in the material at hand.

Leptodactylus maculilabris Boulenger

Figure 13

Leptodactylus maculilabris Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, pp. 404-405 (type locality Costa Rica. C. F. Underwood coll.); Nieden, Das Tierreich, Lief. 46; Anura I, 1923, p. 476.

Leptodactylus poecilochilus (part.) Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 106-107.

Diagnosis: Snout as long as eye, nostril nearer tip of snout than eye; interorbital space equals width of an eyelid; tympanum two thirds eye diameter; first finger longer than second; digits without fringe; a tarsal fold; heel to midway between eye and snout tip.

Description of species: (From type description). Snout rounded, scarcely prominent, as long as the diameter of the orbit; nostril nearer the tip of the snout than eye; interorbital space as broad as the upper eyelid; tympanum very distinct, nearly two thirds diameter of eye.

Tongue oval, slightly nicked behind. Vomerine teeth in two slightly curved series behind choanae, narrowly separated mesially, extending outwards as far as the outer border of choanae.

Fingers moderate, first much longer than second; toes slender not fringed; subarticular tubercles strong; sole smooth with a small, oval, inner metatarsal tubercle; a tarsal fold; tibiotarsal articulation reaches midway between eye and end of snout.

Skin smooth; a glandular fold on each side of the back from eye to groin; another from eye to shoulder; a discoidal ventral disc.

Color: Pale brown above, glandular folds black-edged; a dark brown triangular blotch on the back of the head, the base between the eyes, the apex between the shoulders; sides of head whitish, with a black canthal streak, and three dark brown spots on the tip, the second extending to the eye; sides of limbs with large dark brown spots; a white dark-edged streak along the back of the thighs; uniform white beneath.

Measurements: Snout to vent 43 mm.

Remarks: Known from a single specimen.

The specimen that I am describing is from Los Diamantes, near Guápiles, Costa Rica.

Diagnosis: (RCT. No. 2476.) A small species (43 mm. ♀, 35 mm. ♂) with the venter nearly uniform flesh-white below, with very fine powdering of pigment on chin and breast; above pale brown with or without the black edging on the dorsolateral glandular ridges; tympanum length three-fourths eye length; heel to



FIG. 13. *Leptodactylus maculilabris* Boulenger. R.C.T. No. 2476; Los Diamantes, Costa Rica. Snout-to-vent length, 35 mm.

front of eye; a few enlarged lateral tubercles or pustules in a more or less linear diagonal row; first finger at least slightly longer than second; first finger of males with two lateral spines; vomerine teeth in transverse elongate series.

Description of the species: Head rather narrow oval, its greatest width (12 mm.) less than length (13 mm.); snout projecting slightly (.8 mm.) beyond lip; tympanum large, longer than high, its length (3 mm.) equal to three fourths eye length (4 mm.); the distance

between tympanum and eye more than half greatest diameter of tympanum; eye length less than length of snout (5.3 mm.); width of an eyelid (3 mm.) approximately equal to the interorbital interval (2.96 mm.); canthus indicated, rounding somewhat; a distinct concavity in loreal region behind nostril; a strongly defined supratympanic fold beginning below corner of eye, covering upper edge of tympanum and then curving down to near arm insertion; groove from lower jaw borders tympanum; a distinct glandular area in front of arm insertion but no specific tubercle.

Choanae small, widely separated, the diameter of one is contained in distance between, four times; vomerine teeth in two transversely elongate fasciculi, the tooth-rows considerably behind posterior level of choanae on a level with the transverse palatine ridge, extending out to near the level of the middle of choanae; ten to twelve teeth in each fasciculus, the two very narrowly separated mesially; palatal glands opening in a short straight palatal groove a little closer to level of choanae than to the front of palate; vocal slits elongate, the slits opening very near the jaw; tongue nearly as wide as long, notched behind.

Arm short, the wrist failing to reach the tip of snout; no tubercles below elbow; no evidence of a ridge or tubercles on under side of arm; first finger thicker at base, and somewhat longer than second; first finger bearing a pair of spines (at this time naked not covered with horn, the normal horny covering probably lost accidentally or shed); the digits slightly thickened at tips with slight ridges on inner side of second and third digits; subarticular tubercles six, somewhat rounded; no supernumerary tubercles on hand; inner metacarpal tubercle rather large, elongate, the proximal spine arising from its side; outer (palmar) tubercle large, somewhat bifid.

Leg short, the heels fail to overlap when legs are folded; heel to front of eye; a well-defined tarsal ridge somewhat diagonally placed more than two thirds of the length of the tarsus; no trace of an outer fold; toes with a vague web remnant and distinct skin fringes to small terminal discs; subarticular tubercles strong; no supernumerary tubercles; under surface of foot and tarsus with minute spinose granulations unequally distributed; an elongate inner metatarsal tubercle, a slightly smaller outer.

Skin on head and anterior part of back, smooth (under a lens fine corrugation is discernible); dorsolateral glandular ridge indefinite; a series of somewhat pustular glandules on posterior part of sides; some fine spiny glandules on rump and upper surface of

thigh and tibia; glandular areas in front of arm insertion in postaxillary region extending on to breast on back of tibia and thigh.

Color: Light brownish above, with a triangular dark mark crossing head and eyelid, the apex on shoulders; somewhat lighter band in front of triangular spot; dorsolateral folds more or less edged with darker; sides lighter; venter flesh-white with some powdering of pigment on chin and breast, much less on abdomen; indefinite spotting on legs and posterior side of tarsus; back of thighs reticulated with brown and dull white; an elongate dark-edged light spot on outer part; darker under hands and feet.

Measurements in mm: Snout to vent, 35; width of head, 12; length of head, 13; eye length, 4; tympanum, 3 x 2.4; arm, 19.5; hand, 8.6; leg, 54; tibia, 16.6; foot and tarsus, 27.7.

Remarks: I have examined other specimens of this species from Los Diamantes and Turrialba. The smaller specimens have no trace of pigment of venter.

Genus *EUPEMPHIX* Steindachner

Eupemphix Steindachner, Sitzungsab. k. Akad. Wiss. Math.-natur. Cl. Wien, vol. 48, 1863, p. 188.

Type of genus: *Eupemphix nattereri* Steindachner.

A single diminutive species, long treated under the genus *Engystomops*, presumably occurs in Costa Rica, since its range is said to extend from Veracruz in Mexico to Venezuela.

Eupemphix pustulosus (Cope)

Paludicola pustulosa Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 15, Aug., 1864, p. 180 (type locality, New Granada, on the River Truando, W. S. Wood, coll.).

Microphryne pustulosa Cope, Journ. Acad. Nat. Sci. Philadelphia, N.S. vol. 8, pt. 2, p. 155; Proc. Amer. Philos. Soc., vol. 18, 1879, p. 267 (Tehuantepec).

Microphryne (Paludicola) pustulosa Sumichrast, Bull. Soc. Zool. France, vol. 5, 1880, p. 189 (Habits; Tapaná, Oaxaca).

Engystomops pustulosus Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 275 (Tehuantepec, Mexico); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb., 1901, p. 242 (Tehuantepec); Ruthven, Zool. Jahrb., vol. 32, 1912, pp. 300, 308-309 (color and habits; Cuatolapam, Veracruz); Kellogg, U. S. Nat. Mus. Bull., No. 160, 1932, pp. 76, 77-81 (Cosolapa, Santo Domingo and Tehuantepec in Oaxaca).

Bufo (Microphryne) pustulosus Peters, Monatsab. Akad. Wiss. Berlin, 1873, p. 616 (Chiriquí); Brocchi, Études des batraciens de l'Amérique Centrale; Mission Scientifique au Mexique et dans l'Amérique Centrale, pt. 3, sect. 2, livr. 2, 1882, p. 86, pl. 8, figs. 1, 1a-1d.

Eupemphix pustulosa Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 1, 1888, p. 188; Nieden, Das Tierreich, Lief. 46, Amphibia, Anura I, 1923, p. 165, fig. 215 (Mexico to Venezuela); Noble, New York Acad. Sci., vol. 30, Oct. 31, 1927, pp. 87, 88 (life history).

Diagnosis: A diminutive toadlike species reaching a length of about 30 mm.; no vomerine teeth; no maxillary teeth. Choanae partly concealed by overhanging jaw; vocal sacs and a large external subgular vocal sac.

Description of species: Body squat, toadlike; head small, snout short subacuminate; eye large, its length equal to its distance from the tip of snout; nostril nearer to median point on lip than to eye; tympanum small (more or less concealed by skin in most specimens); parotoid gland large, subtriangular, lying behind tympanum; width of interorbital space equals distance of nostril to eye, greater than width of upper eyelid; canthus rounded, loreal region vertical or but slightly sloping to lip.

Tongue small, not notched or emarginate behind; choanae large partly concealed by overhanging palatal shelf; a large subgular vocal sac, vocal slits present in mouth; no vomerine or maxillary teeth.

Skin above very rough, granular and wartlike the larger pustules complex composed of a granule surmounted by a small spine and surrounded by other granules often in rosette form; the roughened areas extend out to limbs; ventral surfaces smooth, somewhat areolate or finely granular; often a diamond-shaped or an inverted-V-shaped area on back outlined by small tubercles or short folds; tubercles on side usually large; a pair of especially enlarged parotoidlike glandular tubercles on side; frequently a skin fold across breast, prominent in males; one or more prominent tubercles at corner of mouth; ventral and posterior part of thigh granular. Usually a series of glandular tubercles about anus.

Limbs rather short; fingers slender, free from web, first not extending beyond the second; no subarticular tubercle on penultimate finger joint; supernumerary tubercles on palm; two large palmar callosities or tubercles.

Third toe much longer than fifth; an elongate inner and a small outer metatarsal tubercle; none or but a very low tarsal fold, terminating in a prominent conical tubercle; tips of digits somewhat flattened, but not or negligibly widened; only a trace of a web with a fringe indicated on edge of digits; supernumerary tubercles on soles; heel reaches to parotoid gland or eye; when legs are folded at right angles to body, heels touch or are slightly separated.

Color in life: General color above ash-gray, with regular or irregular blotches of darker color; warts usually reddish or orange on anterior part of body, darker on posterior parts; a small orange spot on back between shoulders which is usually enclosed by an inverted

V-shaped black spot or a diamond-shaped black spot; an interorbital bar usually present; a narrow median line in sacral region cream or orange in color; lateral parotoid usually yellow or orange in definite contrast to ground color (easily observed in preserved specimens); granules on mouth angle cream; a large white area usually present on arm, with a dark bar crossing the forearm; hind leg barred with black forming a continuous pattern when leg is folded; folds formed by vocal sac blackish; breast dark, with black abdominal spots on a dirty white ventral coloration.

Measurements in mm.: (EHT-HMS No. 2308 largest specimen.) Snout to vent, 30.2; length of head, 8; width of head, 8.1; arm, 19; leg, 35.5; tibia, 11; foot and tarsus, 16.5.

Remarks: I have not found the species in Costa Rica, but it is included in the fauna since it occurs both north and south of this country. In Mexico no constant variations have been observed in the various populations examined, save that the northern specimens are almost invariably more rugose than specimens from farther south. The lateral gland is almost universally present. The secretion has the same yellow appearance as that from the parotoid on the neck.

Specimens were found in the savannah areas in Veracruz, usually about small pools in the evening or at night. The call is a chirp of a rather deep pitch and with the quality of the call of a dove. Two or three floating "nests" containing eggs were found, which seemingly belonged to this species. At Tierra Colorado in Veracruz the specimens were found around pools in the forest. In Chiapas specimens were found at night along the railroad, calling from the banks of small pools.

They range from central Veracruz throughout Central America to Venezuela. I have not examined specimens from Costa Rica.

Genus *MICROBATRACHYLUS* Taylor

Type of the genus: *Microbatrachylus hobartsmithi* Taylor.

Species of this genus have a strong sexual dimorphism in the size of the tympanum. Males lack the vocal slits and sac, but have a tympanum whose diameter often equals the length of the eye. A distinct inguinal gland is present in both sexes, the individual glands visible under a lens. The gland is usually proportionally largest in the more diminutive species, often reaching the size of the tympanum, or rarely the size of the eye. All of the known species are small or diminutive and in Costa Rica the males vary between 15-25 mm. in length, the females 18-30 mm.

Many of the Mexican forms of the genus have no or only a trace of vomerine teeth, while others have them rather well developed. All of the Costa Rican forms known have vomerine teeth developed to a greater or lesser extent. The ventral disc is not especially pronounced, but usually lateral folds are present on the venter that extend back to the median point of the thighs and do not connect to form a discoidal fold some distance in front of the thigh as is typical of the species of *Eleutherodactylus*.

This seems to be due to a subcutaneous membrane that runs transversely and connects the skin to the muscles of the abdomen. In *Microbatrachylus* the membranes, if present, follow the lateral disc-folds to the thighs and are nearly longitudinal instead of transverse in position. In all the species the subarticular, supernumerary, metatarsal and metacarpal tubercles are especially well developed. The finger-discs are absent or smaller than toe-discs and many forms have at least certain of the discs asymmetrical.

Careful collecting in Guatemala, Honduras, and Nicaragua will doubtless prove the presence of species of this genus in the territory intervening between Mexico and Central America. One may also expect to find the species extending into territory south of Costa Rica and into South America.

KEY TO COSTA RICAN SPECIES OF MICROBATRACHYLUS

1. Skin with several longitudinal folds, the outer ones tending to be parallel (six to eight folds usually indicated). Heel reaches beyond eye, often half way to nostril; tympanum of male never equal to eye length 2.
 Skin folds partially parallel; heel reaching a variable distance; diameter of tympanum of male often reaching eye length or more 3
2. Chin, breast and venter more or less heavily pigmented; first and second fingers of near same length, but the first usually largest; body heavier; inguinal gland smaller; length in mm. 27.5 ♀, 22.5 ♂ *polyptychus*
 Chin (except for outer edge), breast and venter nearly pure white; second finger a little longer than first; body slenderer; inguinal gland larger; length in mm. 23 ♀, 17.2 ♂ *reaki*
3. Larger species (25-30 mm. ♀); females without a distinct pair of dorsal folds running forward to shoulders, where narrowly separated they suddenly diverge towards eyelids; toes not strongly pointed; discs not conspicuously asymmetrical. 4
 Smaller species (17-21 mm. ♀; males 13-14 mm.) with a pair of folds diverging from shoulders to eyelids; digital tips pointed; middle toe-discs strongly asymmetrical 5
4. Large form (30 mm. ♀, 23 mm. ♂); a pair of somewhat symmetrical, curved folds on shoulders, widely separated; other

- folds broken into a large number of elongate tubercles or short ridges; a more or less distinct lighter (often bluish-white), chevron-shaped band just back of shoulder region; teeth in oblique groups; leg longer, the heel reaching between eye and nostril; finger discs not wider than digits; abdomen more or less granular, often strongly so. *underwoodi*
 Length 25.5 (sex ?); a chevron-shaped mark may be present on shoulders; skin of back "thrown into delicate longitudinal parallel folds which are easily lost"; abdomen smooth; heel reaches orbit [bransfordii]
5. Somewhat larger; folds on back not forming an hourglass figure. Chin heavily pigmented, venter cream; broad, triangular, blackish mark covers vent and back of thighs, cut by a narrow transverse cream stripe; length 21 mm. *stejnegerianus*
 Smaller form, venter not cream colored or white, but pigmented; the granules sometimes lighter. Venter strongly granular; less than 20 mm. in length 6
6. Chin smooth; the folds on back often forming an hourglass figure; a straight fold continues back from the tympanic fold; body and limbs granular and tubercular; head moderately smooth; inguinal gland often whitish; outer metatarsal tubercle half size inner; 18.3 mm. ♀, 23 mm. ♂ *persimilis*
 Venter smooth; dorsum nearly smooth; outer metatarsal tubercle nearly as large as inner; folds on back not forming an hourglass-shaped figure; four small black spots on back; 17 mm. ♀ *costaricensis*.

Microbatrachylus underwoodi (Boulenger)

Figure 14

Hylodes underwoodi Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 340 (type locality, La Palma, Costa Rica, 1600 m. elev. Underwood coll.)
 Günther, Biología Centrali-Americana; Reptilia and Batrachia, Aug. 1900, p. 229, pl. 66, fig. D. Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 435-436.

Diagnosis: A small frog, maximum length for females 30 mm. males approximately 23 mm.; no distinctly widened discs on fingers, very small discs on toes; no web between digits; first and second fingers of very nearly equal length; venter granular; very strong subarticular tubercles; supernumerary tubercles on digits as well as on palm and sole; an elongate tarsal fold often discontinuous; an elongate, cream-colored gland between tympanum and arm; tympanum of female one half of eye length, of male, diameter usually equal to eye length; a small inguinal gland; vomerine teeth present.

Description of species: (K.U.M.N.H. No. 24872, Isla Bonita, Volcán Poás, eastern slope 5600 ft. elev.). Body rather heavy, head oval; the canthus distinct; loreal region slightly concave, the sides sloping obliquely to lip, part above lip granular; length of

snout 4.4 mm.; diameter of eye (3.3 mm.) a little greater than distance between eye and nostril; internarial distance (3.9 mm.) equals the interorbital width, slightly greater than width of an eyelid (3.8 mm.); latter with numerous tubercles and a lateral ridge, usually continuous with supratympanic ridge or fold that tends to run back sending down an indistinct branch behind tympanum; a pair of elongate tubercles between tympanum and arm insertion, usually

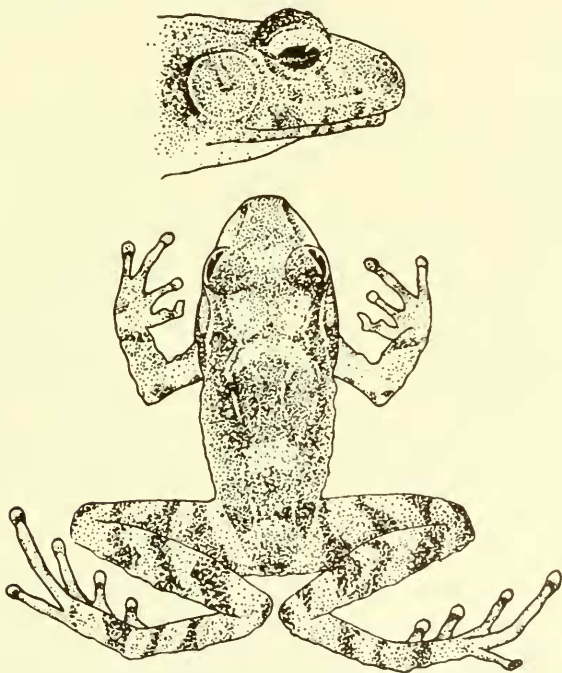


FIG. 14. *Microbatrachylus underwoodi* (Boulenger). K.U.M.N.H. No. 24828; Isla Bonita, Volcán Poás, Costa Rica; snout-to-vent length, approximately 29 mm. Head, much enlarged.

fused into a single cream-colored ridge; tympanum subcircular a little higher than long (2.5×2.2 mm.) the greatest diameter .65 percent of eye length. (In males the tympanum is longer than high and the greatest diameter is .9 of eye length or equal to it.)

Vomerine teeth in two transversely oval fasciculi, somewhat diagonally placed, extending out as far as inner level of choanae, and reaching back to transverse bony palatal ridges or a little behind them; teeth numerous (8-10), in somewhat curving series; palate slightly trough-shaped,—not on a single plane; choanae flair

out lateral to their anterior bony border; tongue irregularly oval, wider behind than in front, not emarginate, shaped somewhat like a grain of maize. (Males without vocal sac or vocal slits.)

Wrist reaches tip of snout; first and second fingers of equal length; tips of fingers slightly oval, scarcely wider than digits, the two outer fingers bearing a transverse terminal groove; subarticular tubercles very large, with six supernumerary tubercles on palm; two metacarpal tubercles, inner large, elevated oval a third length of first finger, outer subcircular elevated and distinctly single; a prominent tubercle on outer side of wrist; ventral and posterior surface of arm strongly tuberculate; fingers with lateral ridges indicated; tibiotarsal articulation reaching slightly beyond eye; toes with distinct small discs, those of the inner and outer toes smallest, the discs but little wider than digit, those of inner toes unequal in size slightly asymmetrical the largest wider than digit, measuring 1 mm. in width; subarticular tubercles large, subconical, strongly elevated anteriorly; numerous supernumerary tubercles on sole, even intercalated between subarticular tubercles (absent or scarcely indicated in some specimens); a low elongate inner tarsal fold; a row of rough tubercles on outer edge of tarsus; an elongate oval inner metatarsal tubercle, a smaller conical outer tubercle; dorsal surface of thigh strongly tubercular; under surface of tibia, front face and part of the posterior surface of thigh, and an area in groin shining smooth.

Skin of dorsal surface and lateral surfaces of body strongly tubercular or granular, the granules largest in postaxillary region; on back a more or less continuous skinfold begins at the back edge of eyelid, courses diagonally back onto the interscapular region then curves sharply outward for a short distance then continues back as a somewhat angular or sinuous fold along the dorsolateral region; at the point where the curve begins, a small curving branch is given off and runs forward a short distance, and near the middle of curve a branch begins and runs in and back parallel to its fellow; a hair-fine median fold present; some indistinct folds or rows of tubercles on sides of rump that may or may not connect with outer anterior fold; venter largely granular, while breast and chin are smooth; inguinal gland relatively small; ventral disc indistinct.

Color: Dark brown to blackish brown above, the marking indistinct unless submerged in water; a dark mark at tip of snout followed by a lighter area, then another spot of dark followed by a very narrow dim interorbital light mark; behind this a broad irregular interorbital dark spot; a broad W-shaped pattern bordering

occiput but extending behind it; following this is a transverse chevron-shaped or curving light mark (usually constant and easily observed in most specimens); behind this a large somewhat triangular median spot followed by a small spot; on upper sides of rump two somewhat triangular spots with a terminal spot connecting with the darker anal area. The ground color of back is olive, of sides yellowish olive; lip bearing four more or less distinct spots, two from eye separated by dull cream; tympanum dark, and a dark line following the supratympanic fold; anterior part of side dusky. In life the groin and inner anterior part of thigh pinkish to red (flesh in preservative); back of thigh dusky with a pinkish wash (brown in preservative), the tubercles on its lower edge whitish; chin in life lavender with a yellowish tinge on venter. (Sometimes the pinkish red areas are salmon, sometimes approaching magenta-pink); sole of foot purplish, larger tubercles on foot and hand pure white; some fine dusky flecks on chin; a peppering of pigment on ventral surfaces; legs spotted or barred with black.

Measurements in mm.: Snout to vent, 30; length of head, 11; width of head, 11.8; length of snout, 4.4; length of eye, 3.3; height and length of tympanum, 2.3 x 2.1; arm, 18; hand, 7; leg, 48; tibia; 16; foot and tarsus, 22.

Remarks: This species is one of the common forms in the collection. Specimens were taken at Turrialba, Picayas, Isla Bonita, Morehouse Finca, Moravia. More than a hundred specimens are at hand.

Microbatrachylus polyptychus (Cope)

Hylodes polyptychus Cope, Proc. Amer. Philos. Soc., vol. 23, 1886, p. 276 (type locality, Nicaragua, L. F. Bransford, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 15; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June and August 1900, pp. 228-229, pl. 66, fig. c. (Hda. Rosa de Jericho, Nicaragua and La Palma, Costa Rica); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 15.

? *Eleutherodactylus polyptychus* Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, 1921, p. 161 (Monteverde and Guápiles); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, pp. 410, 418 (Barro Colorado Island).

Diagnosis: This diminutive form may be recognized by its small size (females 27.5, males 22.5), elongate dermal plicae six to eight in number on dorsal and dorsolateral regions; paired lateral lighter stripes or areas usually connecting with lighter coloration of groin and posterior part of side, granular belly, very small digital discs, with well-developed supernumerary tubercles on sole, palm, and tarsus. In life there may be some pinkish or pinkish lavender color in the stripes; no vocal sac; inguinal gland small; venter granular.

Description of species: (K.U.M.N.H. No. 24954 ♀, Isla Bonita, Volcán Poás, Costa Rica). Head rather narrower than body (female, gravid), snout a somewhat pointed oval; canthus distinct, the edge bearing a very low, indistinct ridge, (discernible under lens), which is continued as a much thickened ridgelike edge to upper eyelid, but not continuous with the supratympanic ridge or fold; length of eye (3.4 mm.) greater than distance to nostril (2.6 mm.) but shorter than snout (4 mm.); tympanum higher than wide (2 x 1.6 mm.), greatest diameter about .6 length of eye; tympanum rather high, reaching higher than corner of eye, so that supratympanic fold seems to begin on lower eyelid and curves up, over, and straight back, then curves slightly down for some distance on side as a tubercular fold; tympanum transparent with a median oval pigmented area entering from the top; an elongate glandular tubercle from tympanum to near arm insertion; loreal region sloping obliquely to lip, not or scarcely concave; snout flat with a slight irregular depression between nostrils; eyelid very rugose with two larger tubercles, marking beginning of a body skinfold; width of an eyelid (2.3 mm.) less than interorbital width (2.8 mm.); snout rather broad the width between nostrils 2.5 mm.; width of head (10.2 mm.) slightly less than length (11 mm.); choanae rather lateral, relatively small (larger on left side) with two large transversely diagonal fasciculi behind choanae and not quite reaching inner level; palatal area in front of choanae flares out over edge of choanae; tongue a pointed oval, rounded behind without emargination, free for less than one fourth of its length; (males definitely without vocal slits).

Wrist reaches a short distance beyond the tip of the snout; finger with the tips only minutely wider than digit, outer ones slightly pointed; six subarticular tubercles very large, six large supernumerary tubercles on palm with numerous minute tubercles intermixed; inner metacarpal tubercle strongly elevated; inner tubercle (palmar) large, biscuit-shaped; a row of pearl-tipped tubercles on under side of arm and numerous other small warts and tubercles elsewhere on arm.

Heel reaches halfway between nostril and eye; toes with discs larger than those on fingers, nearly symmetrically oval in shape; large conical subarticular tubercles; numerous supernumerary tubercles of large and small size on sole; a large elevated inner metatarsal tubercle less than one third length of first finger; outer tubercle smaller distinct; a fine inner metatarsal ridge, and scattered

tubercles on under surface of tarsus; no trace of web on hand or foot but some digits may show traces of lateral ridges; scattered minute tubercles on sides of head and dorsum; area about side of neck and anterior half of side of body with large regular granules; latter half of side and front face of thigh, most of posterior face of thigh, chin and breast extremely smooth; venter except on anterior and anteromedial parts with regular granules; posteroventral face of femur and area about vent, granular; back with a series of plicae, the most prominent beginning on orbits as tubercles, passing gradually mediad and posteriorly becoming parallel near middle of body; a faint suggestion of some flat ridges from snout to end of occiput and a median hair-fine ridge extending length of body; dorsolateral fold from eye to groin finely beaded posteriorly; fold from tympanum terminates on side, while above it is a short fold anterior to sacrum; large warts and tubercles behind tympanum and behind arm insertion; minute tubercles of dorsum also arranged more or less in longitudinal rows; above, thigh and tibia very rugose, the largest warts following the transverse darker lines.

Color: Lavender-brown from snout to rump with darker areas arranged as follows: a broad stripe from interorbital area to near back end of occiput in front of which snout is lighter; supraocular areas purplish black; a pair of stripes arising indistinctly at orbits, converge and at back of occiput widen considerably continuing back to sacrum; behind lighter sacral area, an irregular black spot and behind this two narrow lines connecting with the triangular dark area about vent; two elongate darker spots on upper part of side, one behind, one in front of sacrum; area from eye bordering the darker lavender brown, light lavender rose, growing less evident on sides and groin; side of head, neck, and an area on side, back of axilla, dark; a purplish black spot from tip along snout and loreal region separated at tip from its fellow by a vertical cream line; two other large black spots on lip, and some smaller irregular clouding and several indistinct cream spots on both lips; tympanum dark, the diagonal gland cream; limbs including foot barred with black, the heels clay-color above; ventral surface clouded on chin; venter with an indistinct reticulation of dusky; concealed surface of thigh nearly uniform light brown with sometimes a pinkish wash; a transverse cream line runs length of thigh on posterior surface; purplish under foot and palm.

Measurements in mm. of Microbatrachylus polyptychus

	K.U.M.N.H. ^o		
	24958 ♀	24954 ♀	24953 ♂
Snout to vent	27.5	26.2	22.5
Length of snout	4.7	4.8	4
Length of eye	3.8	3.5	3.1
Diameter of tympanum	2.2	2	2.7
Width of head	11.1	10	9
Length of head	12	11	10
Arm	16	15.5	14
Hand	6	7	6.8
Leg	42.3	43	39
Tibia	14	14.5	12.3
Foot and tarsus	21	21	19

Remarks: Specimens were taken at Bataan, Turrialba and surroundings, at Isla Bonita on Volcán Poás, and at Moravia, a total of more than 30. The intensity of the pigmentation may vary in the general pattern of coloration and markings as described. There are three rather notable exceptions.

No. 24958 has a light stripe from the tip of the snout to end of body, narrowly interrupted on occiput, while the chin has more pigment and a longitudinal median light stripe. No. 24953 lacks the white line across the posterior surface of the thighs. These two are from Isla Bonita. One specimen No. 24959 (Turrialba) has the dorsal and posterior lateral surface clay-color, the side of head, neck, and anterior part of side, deep black; legs and arms deep black; chin purplish; venter lavender, clouded; heels clay.

Males differ from females in having a larger tympanum, in having a smaller size and a small nuptial pad on top of first finger. I find no trace of a vocal sac or vocal slits in males. The amount of granulation on the belly is variable, usually only the posterior portion of the venter, and the lateral edges show granulation. Both males and females from Turrialba and surroundings have heavier granulation on venter, covering a larger area, and there are probably greater dorsal rugosities, than in those from Isla Bonita. The inguinal gland is always present, but rarely conspicuous; most specimens have a much rougher skin than that described.

Microbatrachylus persimilis (Barbour)

Figure 15

Eleutherodactylus persimilis Barbour, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, Jan. 30, 1926, p. 193, pl. 14 (type locality, Suretka, Costa Rica, near the boundary of Bocas del Toro Province, Panamá, Professor E. R. Dunn and Mr. Chester B. Duryea, colls.).

^o All from Isla Bonita.

Diagnosis: A diminutive species (18 mm.), the surfaces largely covered with small rough tubercles; a pair of lines, formed of tubercles beginning behind eye tend to converge for some distance toward middle line then continue back parallel, close together for a very short distance; a very well-defined palmar tubercle; an inguinal gland present; discs of all digits rather pointed, that of third and fourth toes distinctly asymmetrical; vomerine teeth



FIG. 15. *Microbatrachylus persimilis* (Barbour). K. U. M.N.H. No. 28359. Morehouse Finca, approx. 4½ mi. S Turrialba, Costa Rica. Actual snout-to-vent length, 18 mm.

strongly developed, widely separated, much behind choanae; ostia pharyngea more than double size of choanae; tympanum of male as large as eye, smaller in females.

Description of species: (From type). Snout moderately pointed, the canthus rostralis distinct but slightly rounded, without a raised edge; area from occiput to tip of snout very flat but minutely corrugated and tubercled; area about nostrils swollen but little and there is no distinct depression between them; the line of the canthus

can be traced to tip of snout; a fold or ridge on outer edge of eyelid and one or more large tubercles or numerous granules on eyelid; loreal region not concave, sloping obliquely to lip, the lores and side of head as far back as jaw angle corrugated or granular; eye moderately large, (2.3 mm.) a little longer than its distance from nostril (2 mm.) but shorter than snout (3 mm.). Tympanum large, transparent amber in color, a little higher than wide, its vertical diameter (1.5 mm.) more than half of eye length, separated from eye by a distance of 1 mm.; a broad flat fold (or skin thickening) extends from eye above tympanum then curves abruptly down behind the tympanum and jaw angle; width of an eyelid (1.4 mm.) a little more than half of interorbital interval (2.5 mm.) distance between nostrils (1.8 mm.), the nostrils much closer to the median notch on upper lip than to eye.

Choanae rather small, only about a third size of Eustachian tube openings (ostia pharyngea); vomerine teeth in two large, widely separated fasciculi placed behind posterior level of choanae; tongue oval, free for one third its length.

Arm short the longest finger extending beyond tip of snout; inner metacarpal tubercle, rounded, strongly elevated, at base of first finger; a single large elevated palmar tubercle; digits distinctly pointed, only tip of third wider than digit; only the fourth with a terminal groove; very strongly developed subarticular tubercles with numerous strongly developed supernumerary tubercles on palm; no trace of web but indistinct lateral ridges on edges of some of the fingers.

Leg short, the heel reaching only to middle of eye; a small inner tarsal tubercle scarcely distinguishable from numerous large subtarsal tubercles; an outer tarsal series of four or five large warty tubercles in a row; a large inner metatarsal tubercle rounded and well elevated; outer metatarsal tubercle smaller, sharply conical; toes with small terminal pointed discs, those of the third and fourth largest and distinctly asymmetrical; terminal grooves present on all discs; subarticular tubercles conical pointing rather forward; numerous supernumerary tubercles on toes and sole; a row follows the outer edge of fourth toes onto tarsus; fifth toe tiny reaching base of disc of third finger; no web, or only a vestige between toes two and three.

Skin of back strongly granular; beginning near the posterior corner of the eye a linear series of tubercles (or continuous tubercular fold) that tend to converge toward the middle of the back;

near the median line they turn back narrowly separated, parallel, thickened where they tend to terminate (only a suggestion of a continuance from this point running back); from the supratympanic fold is a more or less distinct line of tubercles; between these and the terminus of the dorsal lines a short dorsolateral line continues back in sacral region; sides tubercular or granular; granules are irregular and unequal in size; chin and breast smooth or practically so; venter, under side of thigh and an area on each side of vent very strongly granular, the granules usually not contiguous; a smooth area on distal part of posterior face of thigh; a rather large flat, but inconspicuous inguinal gland; inguinal area and front face of thigh smooth; arms granular or tubercular; under side of tibia and top of foot smooth.

Color: Tan with an indistinct interorbital brown spot; brown or blackish spots on the terminal part of the dorsal rows of tubercles; anterior and posterior pair of diagonal spots on sides; a pair of brown or black spots on side of rump; under surface of foot and hand brown; a hair-fine median light line and a similar longitudinal line on under face of tarsus; vent followed by a dim groove; a large triangular blackish mark on back of thighs, the apex at vent; entire ventral surface finely pigmented; a dim narrow line on upper part of lores; a dark spot below eye; trace of a whitish longitudinal line on thighs; legs barred more or less distinctly; a strong mark on supratympanic fold.

Measurements in mm. of Microbatrachylus persimilis

Museum number	K.U.M.N.H.	R.C.T.	R.C.T.	R.C.T.	M.C.Z.
	28359 ♀	543 ♀	2608 ♂	2607 ♂	Type ♀
Snout to vent	18	18.3	13.5	14.6	17.5
Width of head	7	7	5.5	6.2	6.4
Length of head	7	7.2	5.8	6.6	7
Length of snout	3	3.2	2.3	2.7	3
Length of eye	2.15	2.2	2	2.1	2.3
Height of tympanum	1.7	1.4	1.8	1.8	...
Length of tympanum	1.4	1.1	1.95	2.1	1.5
Arm	9	8.9	7	8	8.5
Hand	3.5	3.3	2.3	3	3
Leg	24	24.2	20	22.6	22
Tibia	8.2	8.5	7	8	8.5
Foot and tarsus	11.3	11.8	9.2	10.2	11.8

Variation: There is little variation in the general habitus of these specimens. The males have a proportionally and actually larger tympanum than the females which is, in specimens at hand, longer

than high and practically as large as the eye. The males are somewhat rougher, the tubercles being proportionally higher.

R.C.T. No. 542 is a very dark blackish-brown specimen bearing somewhat diagonal cream spots in the dorsolateral area, beginning behind the level of arm insertion. The anal region has an intensely purplish-black triangular area while the area on each side of the apex is light flesh. The structural characters are the same as those in the type.

No. 28358 has a hair-fine median cream line and a small cream line cutting off the upper part of the black triangle in the anal region. The underside of foot and tarsus are purplish, the tubercles white.

The coloration of the living animals, taken at night were dusky flesh below and brownish to clay or gray above; one or two taken in daylight were brown to reddish brown above and flesh below. The feet were purplish on the soles.

In certain of the specimens the lines of tubercles from eyes may, after their mesial approximation, continue back, diverging somewhat; two whitish tubercles are usually present below the tympanum; males are without vocal sacs or vocal slits; a few tiny nuptial asperities are on the top of the base of the first finger. The whitish line on tibia may be absent.

Remarks: Our collections contain several specimens of this diminutive species. They were found in the region of Turrialba chiefly in the low forest along the Río Reventazón. They were usually found hopping about on the forest floor, sometimes in the day, sometimes at night.

The transparency of the large tympanum and the very large ostia pharyngea permit one to discern light through the buccal region from tympanum to tympanum. The inguinal gland is occasionally present in *Eleutherodactylus* but usually it is very inconspicuous. Here it is relatively large, and forms a bright yellowish white spot as large or larger than the tympanum, and is close to the angle formed by thigh with the body.

[*Microbatrachylus bransfordii* (Cope)]

Lithodytes bransfordii Cope, Proc. Amer. Philos. Soc., vol. 23, Apr., 1886, pp. 274-275 (type locality, "Nicaragua," Dr. J. F. Bransford, coll.).

?*Eleutherodactylus bransfordi* Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Dec. 21, 1921, p. 161 (Orotino, Guápiles and Zent in Costa Rica).

Diagnosis: Small frogs, the heels reach to orbit; teeth in rows in two approximating groups, transverse or slightly arched, extending

out to near level of middle choanae; tympanum, in male, equals eye, in female smaller; canthus distinct, nearly straight; back with longitudinal folds easily lost. Length 25.5 mm.

Description of species: (From Cope *loc. cit.*). "Represented by a number of individuals of small size, but which are adult. The characters are well marked. The legs are short, the posterior when extended only bringing the heel to the orbit. The vomerine teeth are in two transverse or slightly arched series, near together well behind the line of the posterior nares, and not extending exterior to the middle of the latter. The tympanic disc is large, in four of the specimens equaling the diameter of the eye-fissure, in three others not exceeding two thirds of that size. The muzzle does not project, and is slightly truncate, and is about equal in length of the diameter of the orbit. The nostril is nearly terminal, lateral. Canthus rostralis distinct, obtuse, nearly straight. The toes are entirely free, and the dilations moderate. Two metatarsal tubercles, the inner larger. The skin of the back is thrown into delicate longitudinal parallel folds, which are easily lost."

Measurements in mm.: Length of head and body, 25.5; length of anterior limb, 13; of posterior limb from groin, 36; of foot, 17; of tarsus, 7.5; of tibia, 12.

Color: "In the color there is much pink on the upper and concealed surfaces. There are two dark spots on the lip, one below each canthus of the eye. There is a large more or less obsolete spot behind and above the axilla, with an oblique posterior border. There is a dark spot on the parietal region and generally one between the anterior parts of the orbits. There is generally a light open chevron pointing forwards across the middle of the back, with a dark one on front of it. In the largest specimen a pink band extends from the orbit posteriorly to the ilium. Posterior face of femur brown with light specks or finely brown mottled. Other lower surfaces whitish, except that in a few specimens the gular region is obscurely brown mottled.

Remarks: "This species belongs to the short legged group represented by the *L. diastema*, and need not therefore be compared with the *L. podiciferus*, *muricinus* and *rhodopis*, where the heel reaches much beyond the muzzle. From *L. diastema* it differs in the much longer posterior foot, and in the close approximation of its teeth, which form a row and not a fascicle. The tympanum is at all times much larger and more distinct, although it is variable in diameter.

"This species is dedicated to Doctor John F. Bransford, U.S.N., whose researches have thrown much light on the fauna of Nicaragua." (From Cope.)

Microbatrachylus stejnegerianus (Cope)

Hylodes stejnegerianus Cope, Proc. Amer. Philos. Soc., vol. 31, Nov. 17, 1893, pp. 338-339 (type locality, Palmar, Costa Rica, G. K. Cherrie coll.).

Diagnosis: Head flat; canthus distinct concave; tympanum round, diameter practically equals eye; dorsum with folds, and tuberculations between folds. Heel to orbit; digital discs small; limbs pink with dark cross bands; dorsum bistre brown with a pinkish area from eye to sacrum above tympanum. 15 mm. ♂, 21 mm. ♀.

Description of type: Muzzle flat, canthus rostralis distinct, concave, extremely little prominent. Nostril near the extremity and as far anterior to the eye as the long diameter of the eye slit. This latter dimension equals the diameter of the nearly round tympanic membrane. Integument of head smooth; that of back with a delicate median fold, and a fold on each side which diverges at the scapular region and extends to the orbit. Parallel to the latero-dorsal fold is a dorsolateral fold on each side which terminates anteriorly near to the oblique fold just mentioned. Between these folds the integument is tubercular. Sides and belly roughened with small tubercles; breast and throat smooth. Tongue longer than wide, pyriform, scarcely notched. Vomerine teeth in two fascicles well behind the choanae, and farther apart than each one is within the longitudinal line of the internal border of the nares. The heel of the extended hind limb reaches the anterior border of the orbit. Width of head 2.3 times in length of head and body. Digital enlargements small.

Colors: Above a dark bistre brown, with a pink band extending on each side from the eye to the sacrum, passing above the tympanic membrane. Posterior limbs blackish brown, except the inferior side of the femora, which are a lighter brown. Fore limbs pink with brown cross-bands. Belly dirty white, the breast and throat densely dusted with brown. Head uniform blackish brown, with the exception that on the edge of the upper lip there are three pairs of pale vertical bars which represent the borders of three lip-spots.

Measurements in mm.: Length of head and body, 15; length of head at posterior border of tympana, 5.5; width of head at posterior border of tympana, 5.5; length of fore limb, 11; length of fore foot, 2.5; length of hind limb, 24.5; length of hind foot, 11; length of tarsus, 4.5.

Remarks: It is only necessary to compare this species with the *H. polyptychus* Cope (*Proceeds. Amer. Philos. Soc.*, 1885, p. 276) from Nicaragua. In this species the top of the head and especially the eyelids are tubercular, while they are smooth in the *H. stejnegerianus*, and the integument generally is covered with larger and more numerous warts. The muzzle is shorter and wider, and the tympanic disc is only two-thirds the eye diameter. Finally, the series of vomerine teeth are more transversely extended.

This species is dedicated to Dr. Leonard Stejneger, the distinguished zoologist now in charge of the herpetological department of the U. S. National Museum, Washington. It is from Palmar; coll. No. 295. (From Cope.)

Remarks: I have a single specimen of this species taken at San Isidro El General on the Pacific slope, some thirty miles north of the type locality. The specimen is a female and in consequence differs from the male in the character of the tympanum, which instead of having its diameter equal to eye length, is only approximately two thirds of the diameter of the eye.

The following characters also obtain in this specimen (R.C.T. 1035): head flat smooth, eyelid with tubercles; canthus rounded, the loreal region somewhat concave behind nostril; snout barely projecting beyond the mouth; diameter of eye slightly longer than its distance to nostril; tympanum 1.8 mm. long, 1.95 mm. high; the general arrangement on the skin folds or ridges on dorsum the same as in type; width of an eyelid equal to interorbital width; edge of eyelid continuous with canthal line but not continuous with a thickened but very indistinct fold above tympanum, bending down behind it, and followed by a very indistinct fold to above arm, from upper tympanic level; side of snout dark continuing back across upper two thirds of tympanum diagonally to venter at a point somewhat behind arm insertion; behind this diagonal line, side light yellow or pink; two tubercles between tympanum and arm insertion; inguinal gland somewhat diffuse, difficult to discern, amber in color; a small inner tarsal ridge, and an outer also present, more or less distinct; fasciculi of vomerine teeth elevated considerably behind choanae, separated from choanae and from each other by a distance equal to transverse length of one fasciculus; a ridge running forward from fasciculus almost reaches choanae; area of choanal openings about half that of the ostia pharyngea; tongue abnormally flattened, sides nearly parallel, barely notched behind, free for less than one fourth its length; no vocal sac or slits; fingers without distinct discs, rather pointed; toes with small pads very

slightly pointed and somewhat asymmetrical; subarticular tubercles and supernumerary tubercles strong; a large, oval, elevated palmar tubercle; a smaller inner metacarpal tubercle; first and second fingers approximately equal in length; subarticular tubercles on toes strong; no webs; supernumerary tubercles distinct but smaller than on hands; heel to middle of eye; two metatarsal tubercles outer relatively large.

Color: Much as in the type but the stripe from eye to groin less distinct; black behind thigh is cut with a transverse light line and the black triangle above vent is cut by a vertical light line; venter dirty white; the chin, throat and front of breast strongly dusted with brown.

Measurements in mm.: (R.C.T. 1035, San Isidro El General). Snout to vent, 21; head length to jaw angle, 8.9; head width, 7.9; eye length, 2.9; eye to nostril, 2.35; nostril to median notch of lip, 1.6; arm, 12.6; leg, 31.2; tibia, 10; foot and tarsus, 14.

Remarks: Such differences as obtain are I believe largely due to the difference in sex.

Microbatrachylus rearki sp. nov.

Figure 16

Type: K.U.M.N.H. No. 31533, Bataan, Costa Rica, July 25, 1951; Edward H. Taylor coll.

Paratypes: K.U.M.N.H. Nos. 31540-31543, Los Diamantes, 1 mi. S Guápiles; Nos. 30909-30910, 31539-31540, 31544-31546, 30909-30911, 30913, Turrialba; 30912, 31534-31538, Bataan, Costa Rica. R.C.T. Nos. 589, 590, 590a, 590b, Turrialba, C. R.; 1471, 2898, Los Diamantes, C. R.

Diagnosis: A small species (23 mm.) with two irregular, broken dermal, median folds, and three lateral folds on each side; a large inguinal gland nearly area of tympanum; vomerine teeth present; heel to about half way between eye and nostril; diameter of tympanum in female half, in male more than three fourths length of eye; first and second fingers equal or second usually slightly longer; brown or blackish brown above; paper-white below; venter and median ventral part of thighs without pigment; gular region white or finely peppered with black pigment; small but distinct terminal pads, slightly oval or pointed, but only inner toes slightly asymmetrical.

Description of type: Adult female (23 mm.). Head ovably pointed, not as wide as body; canthus rounded, nearly straight; top of head and snout nearly flat, finely roughened (under lens) but

no tubercles or granules; eyelid with tubercles or flat pustules; tympanum subcircular, semitransparent, partially pigmented; greatest diameter of tympanum (1.6 mm.), slightly less than half of eye length, (3 mm.); distance of eye from nostril, 2.2 mm.; length of snout, 3.65 mm.; distance between eye and tympanum about 1.2 mm.; width of an eyelid, (2 mm.), less than interorbital interval



FIG. 16. *Microbatrachylus rearki* sp. nov. paratype. R.C.T. No. 589, Turrialba, Costa Rica. Actual snout-to-vent length, 23 mm.

(2.3 mm.); tip of snout reaches 1 mm. beyond lip; choanae moderate, lateral; vomerine teeth in a small fasciculus (abnormally absent on right side), slightly diagonal, much behind but within inner level of choanae; choanae smaller than ostia pharyngea; tongue distorted in type (in paratype shaped like a grain of maize, longer than wide, wider behind than in front, unemarginate behind free for nearly half its length); (no sac or vocal slits in male).

Arm small the wrist reaching beyond tip of snout; tips of fingers with a small but distinct terminal widening; a large somewhat oval palmar tubercle, a smaller inner metacarpal tubercle; subarticular tubercles and supernumerary tubercles distinct, large; a median ventral row of tubercles under arm; second finger a little longer than first.

Legs not especially short the heel reaching to nearly halfway between the eye and nostril; toe discs distinctly larger than those on fingers; a short inner metatarsal ridge on distal half of the tarsus,

a few indistinct tubercles mark the outer, with some other small granules on the ventral surface; two metatarsal tubercles, inner not more than twice size of outer; subarticular tubercles as large or larger than those on fingers, more elevated, pigmented instead of white as are those on hand; supernumerary tubercles small distinct; when legs are folded the heels overlap one or two millimeters.

Head generally smooth, eyelids tubercular or pustular; skin of dorsum with ridges and folds; a very fine median ridge from snout indistinct except posteriorly; a pair of somewhat irregular median ridges indistinct on occiput but continuing on to rump posteriorly; a pair of ridges from behind eye, converge gradually for some distance where they are interrupted and then continue back on each side to sacrum or beyond; outside of these are two folds on each side beginning behind shoulders but traceable forward more or less as rows of tubercles. Space between ridges, rump, sides of body, most of venter, underside and median posterior part of thighs granular or tubercular; chin, throat, breast, median anterior part of abdomen, front face of thighs and groin shining smooth.

Color: Above variegated blackish brown with a darker area or bar between eyes, the edges sharply defined in front, with a lighter gray bar in front of black; snout somewhat grayish with two darker median areas; loreal region slightly concave blackish to edge of lip, with a few light lip flecks; tympanum brownish with an indefinite darker area across top and continued diagonally downward somewhat; line of cream tubercles from tympanum to arm; latter light on the upper part, partly white underneath; a large lateral dark area on side behind arm followed by two or three dim diagonal darker bars separated by dim lighter areas; inguinal gland cream; groin whitish or pinkish; front and under part of thigh pinkish, abdomen and chin paper-white; some pigment on chin, none on venter; small triangular dark area about vent; remainder of posterior part of thighs somewhat brownish or pinkish; legs brownish indistinctly barred with darker, the tubercles not or scarcely larger where bars cross.

Measurements of the types and paratypes of Microbatrachylus rearki sp. nov.

Museum number	K.U.M.N.H.	K.U.M.N.H.	K.U.M.N.H.	K.U.M.N.H.	R.C.T.	K.U.M.N.H.	K.U.M.N.H.
	30910	31533	30913	31539	2484	30909	30911
	♀	♀	♀	♀	♀	♀	♂
Snout to vent	23	23	22	21.5	20.2	19.2	17.2
Width of head	8	8.2	8	8	7.9	7.9	5.1
Length of head	9	9.2	9	8.8	8.2	8.1	7.5
Length of eye	2.9	3	2.9	2.55	2.7	2.5	2.2
Diameter of tympanum	1.55	1.6	1.4	1.4	1.3	1.4	1.8
Interorbital width	2.2	2.2	2.4	2.1	2.05	2.1	1.8
Width of eyelid	2	2	1.8	1.8	1.8	1.65	1.65
Length of snout	3.3	3.6	3.3	3	3	3	2.7
Arm	13	14.1	14.1	13.2	12	12.3	11
Hand	5	5.2	5	5	4.3	4.8	4.1
Leg	33.3	37	35	35	31	33	28
Tibia	11.2	12	15	11.2	10	10.5	9
Foot and tarsus	15	18	15	15.3	15	15	13

Remarks: The paratype shown in Fig. 16 is from Turrialba, Costa Rica. The outer folds are without dark color and scarcely discernible in the drawing. There is, however, no essential difference in the pattern of the folds and under a lens all of the folds can be discerned. The ridges and tubercles on the legs are less pronounced in the type.

There is considerable variation in the details of coloration, but general pattern remains the same in most of the series at hand. Specimens with the most complete folds have a broad median dark stripe with a pair of dorsolateral gray stripes from eye to rump.

This species may be related to *Microbatrachylus bransfordii* Cope, but that species is a short-legged form, the heel reaching only to the orbit; the teeth are in transverse groups, instead of diagonal groups, the diameter of the tympanum of the male equals eye diameter; the nostril is farther forward; there is no pink lateral band in *rearki*.

There is considerable variation in the details of the folds on the back some portions dropping out, most commonly the paired folds beginning on base of snout and ending on shoulders; sometimes only their posterior portion is left and these with the diverging folds on occiput form a W-shaped pattern. The median fold may extend to the snout.

The ventral coloration is nearly constant. Sometimes some dark spots on sides are dimly rimmed with white.

The species is named for Mr. John Reark who provided me with much transportation and obtained numerous specimens for the collections.

Microbatrachylus costaricensis sp. nov.

Figure 17

Type: R.C.T. No. 372, Morehouse Finca, approximately four miles south of Turrialba, Costa Rica, June 12, 1947. Richard C. Taylor coll.

Diagnosis: A diminutive species without web; without widened discs on fingers and only small ones on toes, the discs slightly pointed and the larger ones somewhat asymmetrical; vomerine

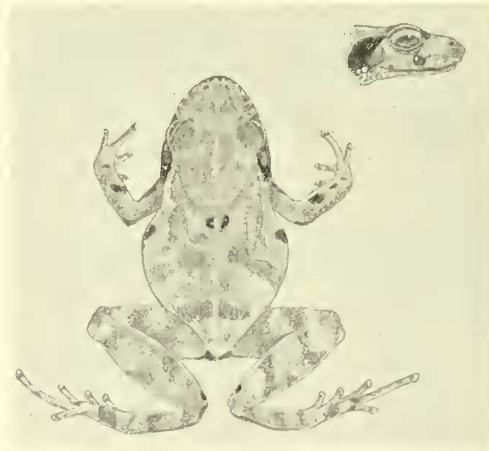


FIG. 17. *Microbatrachylus costaricensis* sp. nov. Type, adult female, R.C.T. No. 372; Morehouse Finca, approximately 4 mi. S Turrialba, Costa Rica. Actual snout-to-vent length, 17 mm.

teeth present in somewhat diagonal rows; ostia pharyngea larger than choanae; inguinal gland nearly equal to area of eye; head and eyelids smooth; chin minutely granular, venter and thigh with rather flat granules.

Description of type: Small adult female (17 mm.) the head rather narrow, distinctly narrower than body; canthus moderately distinct, rounded; upper eyelid nearly smooth but with edge bearing a somewhat thickened ridge that is continuous with the upper edge of a rather broad indistinct low fold above the tympanum, widening somewhat as it bends down behind tympanum; tympanum very distinct, semitransparent, a little higher than long (1.6 x 1.5 mm.), its greatest diameter in length of eye (2.5 mm.), 1.55 times; dis-

tance of eye from nostril, 2 mm.; length of snout, 2.4 mm.; width of upper eyelid, 1.55 mm., much less than interorbital distance (2.2 mm.); distance between tympanum and eye 1 mm.

Choanae rather large, lateral; vomerine teeth present in two triangular fasciculi, their anterior level reaching posterior level of choanae; teeth diagonally placed, converging mesially, separated by a distance equal to or a little greater than width of a fasciculus; ostia pharyngea larger than choanae; tongue narrow anteriorly, much wider and rounded posteriorly, without notch; (male presumably without vocal sac).

Arm short, the wrist barely reaching the tip of the snout; hand very small, digits without distinct discs, rather pointed, the first and second fingers nearly of equal length; subarticular tubercles relatively very large and supernumerary tubercles very distinct but smaller; a well-defined inner metacarpal tubercle; a large rounded palmar pad; a row of indistinct tubercles on underside of arm.

Leg short, the tibiotarsal joint reaching to near middle of orbit; subarticular tubercles elongate pointed, directed forward; supernumerary tubercles small distinct; largest toe discs not half width of tympanum, somewhat asymmetrical; an inner and an outer metatarsal tubercle, the outer only a little smaller than inner, almost no trace of an inner tarsal fold; a very indistinct outer fold.

Dorsal surfaces nearly smooth but with traces of small tubercles especially on shoulders, on arm and legs; chin smooth with only a faint suggestion of granulation; venter with indications of rather large granules; almost entire ventral and posterior surfaces of thigh granular.

Color: Above light brown with a pair of almost obsolete lines or ridges from eyes to a median point near middle of back terminating in two closely approximated black spots; some dim darker marks on snout and a larger dark area on region between eyes and on occiput; a large deep black spot above and behind tympanum partially covering it; deep black spots on arm and a spot on each side behind and above arm insertion; a light brown diagonal band on side and a similar band crossing rump; legs barred with darker color, with a few dark spots near heel and on foot; venter powdered with black, each granulation without pigment; some tiny blackish spots on each side of breast; inguinal gland cream-white; posterior surface of thigh dark lavender the granules lighter; a pair of deep black spots above vent separated by a narrow cream line; a series of small cream spots on upper lip, and a pair of cream tubercles below and behind tympanum.

Measurements in mm.: Snout to vent, 17; head width, 6.6; head length to jaw angle, 7; length of eye, 2.5; greatest diameter of tympanum, 1.6; interorbital width, 2.2; arm, 9; leg, 26; tibia, 8.5; foot and tarsus, 11.4.

Remarks: The relationship of this species seemingly is not closer to one species of *Microbatrachylus* than to another. The type is an adult female with ripe or near ripe eggs. The specimen was taken at night in forest.

GENUS ELEUTHERODACTYLUS Duméril and Bibron

Type of genus: *E. martinicensis*.

The genus *Eleutherodactylus* has been a difficult one to study, the difficulties due largely to the inadequate data given in the type descriptions and in part to the remarkable variation (or what I am interpreting as variation) in the forms discussed under the species *podociferus*. Here there appears to be a linkage between color pattern and the arrangement of glandular folds on the back and to a lesser extent with the character of the tubercles on the digits, palms and soles. There may be considerable variation in some of the other species in regard to color pattern variation but it is very unusual to have varied color patterns appearing with different structural characters. Usually such distinctions serve to delineate species. Only by series of breeding experiments can my present arrangement be confirmed or disproved.

Cope, who named three presumed species, *habenatus*, *podociferus* and *muricinus*, later came to a conclusion that he was dealing with a single species. His material however was doubtless in a bad state since he makes no mention of the varied arrangements of the dorsal folds. I believe that Cope, as well as several other writers, err in regarding these three forms as synonyms of *Eleutherodactylus rhodopis*. I have figured the hand of *rhodopis* and *podociferus* so that others also may distinguish them.

The total number of forms of *Eleutherodactylus* here considered is twenty-seven (species and subspecies).

Certain other species have been reported, i. e. *bocourti*, *longirostris*, *punctariolus*, *ventrimarmoratus*, and *rugulosus*, but in each of these cases I have suspected that the reports may be based on species other than these; but in this I may be wrong. It is highly probable that most of the species occurring in northern Panamá, in the southern part of the Talamanca range, will be found within the confines of Costa Rica eventually.

In the collections at hand are certain forms that I have been un-

able to deal with at this time. Certain of them possibly represent undescribed species.

KEY TO COSTA RICAN SPECIES OF ELEUTHERODACTYLUS

1. Very broad-headed frogs, the head normally wider than body, bearing a well-defined pair of dorsal folds (or rows of tubercles) that form an ornate hourglass-pattern; and pair of bony crests on occiput (except in very young specimens); heel reaches to nostril; length, 103 mm. *rugosus*
 Heads usually not or only slightly wider than body, lacking a pair of bony longitudinal occipital crests 2
2. Vomerine teeth absent, hidden by gums or on very small rather indistinct fasciculi; usually not visible without lens (except *altae* and possibly *pardalis*); tympanum small or sometimes absent 3
 Vomerine teeth (except in *diastema*) in relatively large fasciculi visible to eye, always situated behind posterior level of choanae; tympanum always present, that of male often much larger than female. 7
3. Without discrete white, red or orange spots on thighs and in groin, 4
 White, red or orange spots on thighs and in groin 6
4. Tympanum hidden; no vomerine teeth; first finger shorter than second; discs large, those of toes larger than fingers; skin roughly plicate on head, sides and back; belly strongly granulate; (vocal slits and sac[?]); (size[?]) *lutosus lutosus*
 Tympanum present, variable in size; skin never plicate; rugosity and discs variable; belly variable. 5
5. Skin smooth above and without granulations on venter; a median red stripe; rosy or orange on venter; head broad, depressed, with wide interorbital space; vocal sacs and slits; length, 27 mm. *hylaeformis*
 Skin rather smooth, with a few tubercles on eyelids and back; usually a W-shaped pattern on shoulders; venter granular, yellowish olive above, some pink in groin and on limbs; entire under surface with a peppering of dark pigment; length 24 mm. *ridens*
6. Silvery white spots on side and anterior aspect of thigh; tympanum very indistinct one third eye diameter; digital discs large, round; inner and outer metatarsal tubercles vestigial; heel to tip of snout; skin smooth, belly granular (vomerine teeth probably present; none mentioned in the description save that it is placed in *Eleutherodactylus*); length, 25 mm *pardalis*
 Coral red or orange spots or stripes on thigh, tibia and groin; grayish flesh on venter; tympanum small less than one third eye length; digital discs large; metatarsal tubercles distinct; heel to middle of eye; skin smooth with some tubercles on head; venter granular; vomerine teeth rather distinct; length, 20 mm. *altae*
7. Toes usually with distinct web or web remnant; if without web, the digits elongate, the discs only moderately large 10

- Toes and fingers relatively short with large digital discs; no web present; vocal sac and vocal slits present or absent. 8
8. Tympanum visible but extremely small, less than one sixth diameter of eye; vocal sac and slits absent in male; variable in color, sometimes dark, sometimes light below; length, 38 mm. . . . *dubitus*
Tympanum larger; a vocal sac and vocal slits present. 9
9. Diminutive species with relatively smooth skin, flat indistinct subarticular tubercles, strong external vocal sac evident; venter not or but slightly granular; vomerine teeth absent or a small pair of vomerine elevations with or without teeth; tympanum of male and female about same size; length, 24 mm. *diastema*
Larger; venter strongly granulate; discs large, equal to half eye length; W-shaped pattern more or less evident on occiput; tympanum one third length of eye. *cerasinus*
10. At least part of toes one half or more webbed. 11
Toes not webbed or less than one half webbed. 12
11. Very large species, somewhat toad-like; toes nearly fully webbed; length, 85 mm. (*vide* Dunn) (*punctariola*)
Smaller species, the four inner toes one half or more webbed; two outer toes less than one half webbed; discs truncate, first finger shorter than second; first finger in male greatly thickened; tympanum of male five sixths eye length; length, 44 mm. ♀, 29 mm. ♂ *crassidigitus*
12. Legs long, the heel of adpressed limbs reaching one or more millimeters beyond snout tip. 13
Heel not reaching beyond snout tip. 21
13. Side of head with a black or purplish-black stripe from tip of snout across lores and tympanum and running down to a point on side of body, contrasting with the dorsal color; only a trace of webs on feet (rarely this dark color is segregated into discrete spots on side of head in *gollmeri*) 14
Side of head and body not so marked. 15
14. Heel reaches several millimeters beyond tip of snout; a straight dorsolateral fold from eye to groin; venter and throat smooth; a broad discoidal disc; sharp tarsal fold, slight trace of web on feet; dim, more or less longitudinal marks on back; limbs dimly barred; length, 60 mm. ♀, 30 mm. ♂ *noblei*
Heel reaches six millimeters or more beyond tip of snout; supratympanic fold continued only to above arm; a pair of small (often black-bordered) tubercles on back, a little behind level of arm insertion; trace of web remnant between three inner toes; no dorsal stripes; very little sexual difference in size; length, 33 mm. *gollmeri*
15. Venter strongly granular, digital discs small; vomerine teeth in two very small groups; first toe shorter than second; heel beyond tip of snout; tympanum one half to one third eye length; toes without web trace, head flat; above brown, yellow beneath; length, 27 mm. *peraltae*
Venter without granulation, smooth or nearly so. 16

16. Entire dorsal surfaces of body and limbs corrugated, visible to naked eye, with a few very small tubercles sometimes evident on rump; body and head relatively slender, with somewhat elongate head; a small web remnant; two inner fingers with small, two outer fingers with large, terminal discs; heel reaches four millimeters beyond snout; vocal sac in male; first finger as long as second; length, 47 mm. ♀, 30 mm. ♂ *talamancae*
 Entire dorsal surfaces not corrugated, or if so, can be discerned with a lens only; usually some trace of folds or rugosities or dorsal surface entirely smooth; body and head not slender; web or web remnants may or may not be present. 17
17. Digital tips wide, truncate; part of toes one fourth to one third webbed; trace of web between three inner fingers; heel 10 mm. beyond snout; a light line under chin; hair-fine dorsal median line; back of thigh black, with white or silver spots; length, 72 mm. *palmatum*
 Digital tips not truncate 18
18. First finger longer than second 19
 First finger not longer than second 20
19. No vocal sac; back of thigh black with silver or white spots; toes one-fourth webbed; tympanum round, its diameter three fourths length of eye; no nuptial asperities on first finger of male; length, 60 mm., ♀, 51 mm. ♂ *pittieri*
 (Vocal sac in males?) tympanum oval one half eye (♀); rudimentary web between inner fingers; toes one-fourth webbed; yellow vertebral line, and yellow gular line; hind part of thigh conspicuously marbled with black and white. *engytypanum*
20. First finger shorter than second; finger discs larger than toe discs; vomerine teeth in widely separated series; tongue sub-round; tympanum narrow vertical oval; skin smooth; (vocal sac?); length, 50 mm. *melanostictum*
 First two fingers equal; tympanum round, almost equal to eye; toes one-fourth webbed; vocal sac and slits present; nuptial asperities present in male on first finger; length, 35 mm. ♂ *fleischmanni*
21. Heel to tip of snout; toes with a small web, canthus rostralis distinct nearly straight, digital discs truncate; outer metatarsal tubercle obsolete; tympanum one half eye-length (sex?); skin nearly smooth or a pair of feeble folds on scapular region; snout projecting beyond nares and lip; length, 26.5 + *ranoides*
 Heel fails to reach nostril 22
22. Venter granulate 23
 Venter not granulate 24
23. Venter finely granular over all or a considerable part of its surface; usually one or two short diagonal skin folds from eyelid; numerous tubercles or nearly smooth; discs large, truncate; vocal sac and slits in males; web remnant only indicated; heel to near nostril; digital discs large truncate; length, 57 mm. ♀, 42 mm. ♂ *platyrhynchus*

- Venter strongly or weakly granular; skin folds variable often an hourglass-shaped figure discernible; discs or finger not or scarcely wider than digits, not truncate; vocal slits in males; color somewhat variable (*habenatus* var.); length under 35 mm. *podociferus*
24. Digital discs of hand not wider than digit; venter smooth or sometimes wrinkled; abdominal discoidal disc often distinct; folds on back, as well as the coloration extremely variable; vocal slits in males; length, under 35 mm. *podociferus*
- Digital discs of hand and foot always more or less widened, at least wider than digit 25
25. First and second fingers equal or of about equal length 26
- First finger longer than second 27
26. Heel to between eye and nostril; no distinct canthus; discs small; digits without trace of web or dermal margins; venter smooth, with a discoidal disc; skin smooth above; tympanum oval two thirds eye female; length, 75 mm. (vocal sac in males?)
euryglossus
- Heel to between nostril and eye; head wider than body; canthus angular; vomerine teeth in oblique groups; venter smooth, finely rugose above; dark brown above, greenish blue marbling on side lighter below with a light (red?) line from eye to sacrum (resembling superficially *Phyllobates lugubris*); discs of fingers and toes well developed about half again diameter of digit, length 38 mm. (sex?) *gaigei*
27. Heel not reaching anterior edge of eye, digital dilations small, flat tubercles under fingers; venter smooth, posterior face of leg black banded with dark areas separated by scarlet areas; posterior side and anterior abdomen blackish or brownish with crimson or orange spots; digital discs small; length, 35 mm.
florulentus
- Heel does not reach tip of snout; lacking web on hand and foot; a tarsal fold; four indefinite longitudinal bands on dorsum; venter smooth, length, 44 mm. (vocal sac in male?) *nubilus*

Fitzingeri having the following known characters, does not fit into this key: Very slim body; vomerine teeth far behind choanae; venter smooth; dorsum smooth, (with a few elevations), flanks granulated; toes with a web remnant; gray brown above with black flecks and streaks especially on limbs; a yellow streak from tip of snout runs under jaw; the tip truncated anteriorly; venter yellowish; snout to vent, 30 mm., hind legs, 54 mm., arms, 18 mm.

Eleutherodactylus lutosus lutosus (Barbour and Dunn)

Syrhophus lutosus Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Dec. 21, 1921, pp. 158-159 (type locality, Navarro, Costa Rica. E. R. Dunn coll.)

Diagnosis: A small frog (no measurements given in the type description) without vomerine teeth; canthus rostralis ill defined; tympanum hidden; first finger shorter than second; discs rather

triangular, larger than discs on fingers; two metatarsal tubercles; belly strongly granular.

Description of species: (From Barbour and Dunn, *loc. cit.*). "Size small, body depressed; head as broad or slightly broader than the body; as broad as long; snout blunt with very ill defined canthus rostralis; orbital diameter about equal of distance from eye to nostril; nostril very near tip of snout; interorbital space about equal to width of upper eyelid; vomerine teeth absent; tympanum hidden; fingers 2, 3 and 4, with slight but well defined dilatations; first without disc and shorter than second; toes long, second and fourth equal; no trace of web; with discs more triangular and slightly larger than those of fingers; subarticular tubercles, long, rather well developed; a very indistinct outer, and a long, rather well developed, inner metatarsal tubercle; tibiotarsal articulation reaching to half way from eye to tip of snout; skin roughly plicate on head, sides and back; belly strongly granular.

"Color in alcohol (fresh, well preserved specimen not shrunken): Dirty black, a faintly defined middorsal light thread like mid-line; thighs narrowly cross barred black on dark brown. Belly dirty dark brown."

Eleutherodactylus hylaeformis (Cope)

Phyllobates hylaeformis Cope, Journ. Acad. Nat. Sci. Philadelphia, 2nd ser., vol. 8, 1875, p. 107, pl. 23, fig. 8 (type locality, Talamanca, Pico Blanco, 7000 ft. elev. Costa Rica; W. Gabb coll.); U. S. Nat. Mus. Bull. 32, 1882, p. 17; Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 67; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 1882, pp. 196-197.

Syrhophus hylaeformis Boulenger, Proc. Zool. Soc. London, 1888, p. 206.

Syrhaphus hylaeformis Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Apr. 1900, p. 218.

Syrhophus hylaeformis Nieden, Das Tierreich, Lief. 46, Anura 1, 1923, p. 401.

Diagnosis: A small species 27 mm. in length; canthus obtuse; skin smooth above and below. Red stripe on middle of dorsum.

Description of species (From Cope): "A species of medium size, resembling a *Hyla* in its habit. The head is a broad oval, and the muzzle is not produced, but is depressed. Interorbital space wide, plane; canthus rostralis obtuse, straight, lores oblique. Tongue an elongate oval narrowed before, flat, one-half free. Ostia pharyngea very minute; membranum tympani one-sixth of orbit. Fingers and toes free, dilatations rather large. Skin smooth above and below.

"Color above rich brown, divided on the vertebral line by a narrow red stripe. Femora light brown before and behind. Gular region with large vocal sac, of a rose color. Abdomen and inferior surfaces of femur and tibia with a rosy or orange pigment."

Measurements in mm.: Length of head and body, 27; length to orbit, 3; to angle of jaws, 9; width between jaw angles, 10; width between orbits, 3; length of arm, 17; hand, 6; hind limb, 37; hind foot, 18.

Presumably this species is known only from the mountain of Pico Blanco, at 7000 ft. elevation, the type locality. I am not sure as to the relationship of this species but doubt that it is close to *Eleutherodactylus ridens* or *Eleutherodactylus caryophyllaceus* both of which have the venter granulate.

Eleutherodactylus ridens (Cope)

Figure 18

Phyllobates ridens Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 131 (type locality, Río San Juan, Nicaragua. Robt. Kennicott coll.); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 155 (Panamá); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale. Étude sur les Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 66; Boulenger, Catalogue of the Snakes in the collection of the British Museum, 2nd. ed., 1882, p. 197.

Hypodictyon ridens Cope, Proc. Amer. Philos. Soc., vol. 22, July 29, 1885, p. 383, (establishes the genus *Hypodictyon* for the forms with granulated venters).

Syrhopus ridens Boulenger, Proc. Zool. Soc. London, 1888, p. 206.

Syrhaphus ridens Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Apr. 1900, p. 216.

Diagnosis: Maximum length 24 mm.; heel reaching near front of eye; tympanum moderately distinct, rather high on side of head, its vertical diameter (1.2 mm.) more than one third eye length (3.7 mm.); a vague W-shaped mark on occiput, preceded by a darker median mark that touches an interorbital dusky bar; posterior half of body with indistinct diagonal lines directed toward groin, converging on median line; limbs more or less barred; a small tarsal fold or tubercle; a large inner metatarsal tubercle equal or nearly equal to distance between tubercle and disc of first toe; vomerine teeth present, but indistinct, much behind choanae and not on elevated bosses; venter granular, chin smooth.

Description of species: (From K.U.M.N.H. No. 28254 ♀, taken near Guápiles, Costa Rica.) Head broad, triangular, its width (9 mm.) greater than its length (8.6 mm.); canthus rostralis rounded but distinct; nostril not swollen; tip of snout rounded, projecting 1 mm. beyond lower lip; length of eye (3.7 mm.) shorter than snout (4 mm.); nostril 2.5 mm. from eye, much closer to notch in upper lip; loreal region not or but slightly concave, sloping obliquely to lip: the line of the lower jaw posteriorly curves back upward, strongly overlapping upper jaw; eye large the upper lid (2.8 mm.) wider than interorbital space (2.4 mm.); tympanum higher than long (1.2 mm. x .95 mm.) its greatest height little more than one third length of eye; tongue longer than broad, minutely

notched behind, thickened somewhat on posterior edge, and broader behind than in front; (in other specimens not widened behind but about same width and the terminal parts thickened); tongue free behind for more than half its length, and widely free on sides; vomerine teeth very indistinct, but visible under lens, in two groups between inner levels of choanae, but a little behind their posterior level; choanae lateral in position, moderate in size.

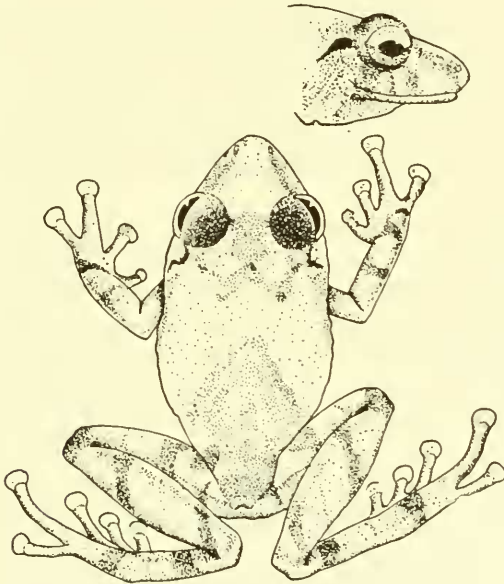


FIG. 18. *Eleutherodactylus ridens* (Cope). K.U.M.N.H. No. 28254 ♀; Los Diamantes, near Guápiles, Costa Rica; snout-to-vent length, 23.2 mm. The tympanum is a little more distinct in lateral view than is shown.

Skin of dorsum smooth with a few indistinct tubercles on top of head, a prominent one on eyelid, five on occiput marking points of the W-shaped mark; one large tubercle behind angle of jaw and a few indistinct ones on rump; sides anteriorly strongly granular as is venter and most of the ventral part of femur and a broad area on each side of vent; a distinct heel tubercle; chin, throat and limbs smooth; a supratympanic fold curves up and over tympanum, partly obscuring its upper edge.

Arm short, the wrist fails to reach snout; a smooth tubercle on dorsal surface of arm and two or three on the ventral surface; fingers without trace of web, moderately long, the first smaller and shorter than second; all digits with discs increasing from first to fourth in

size, the fourth more than double area of first but not quite double its width; subarticular tubercles and supernumerary tubercles distinct on palm; a ventral inner metacarpal tubercle at base of first finger; median palmar tubercle bifid or nearly tripartite.

Legs short, heel reaching anterior edge of eye; heels touching when legs are flexed at right angles to body; toes without trace of web, all with discs, those of inner toes small, scarcely wider than digits, those of outer toes large, equal or nearly equal to those of outer fingers; subarticular tubercles distinct; supernumerary tubercles of sole small indistinct; a large inner metatarsal tubercle, its length equal to distance from tubercle to the disc; a small outer tubercle present. A small tarsal tubercle one third the length of tarsus back from inner metatarsal tubercle; a prominent heel tubercle.

Color: Generally yellowish olive on dorsum; upper surface of fingers pinkish; area in groin, the front and most of posterior surface of thigh, part of tibia and foot reddish pink; sides yellow, gradually merging into reddish pink of groin; anal region olive-gray. Dusky pigment in preserved specimens shows a very dim W-shaped pattern on occiput, and in middle of back is the apex of a triangular darker area the outer edges of which are fairly distinct, broad diagonal stripes; a dim dusky bar between eyes followed by a contiguous interorbital spot; a dim line on upper loreal region and a discrete spot on fold and tympanum behind eye; granular area in anterior part of side somewhat darker; legs and arms with dim dusky bands and considerable dark pigment on outer posterior faces of thigh; entire under surfaces except discs and tubercles of feet with a peppering of dark pigment.

Measurements in mm. of Eleutherodactylus ridens

	NUMBER		
	28254 ♀	28252 ♂	28253 ♀
Snout to vent	23.2	17.	21.3
Length of snout	4.	2.8	3.7
Length of eye	3.7	2.6	3.
Width of head	9.	6.	8.4
Length of head	8.6	6.5	8.
Upper eyelid	2.8	2.	2.3
Interorbital space	2.4	2.	2.1
Tympanum	1.2 x .95	.8 x .8	1. x .8
Arm	12.3	9.	11.3
Hand	6.2	5.3	6.
Leg	33.5	24.5	30.
Tibia	11.5	9.	11.
Foot and tarsus	15.2	12.	14.9

Variation: No. 28253 has the general color darker, and the diagonal stripes more distinct from middle of back to groin; just behind these is another pair, more or less distinct, and behind these some indefinite spotting; everywhere on the dorsal surfaces the pigment is a little heavier. In this specimen the skin is slightly rugose in the posterior part of back and on upper surface of leg; the tibiotarsal articulation reaches a millimeter beyond eye.

The male has a vocal sac, and vocal slits are present in the mouth. In some specimens, the tongue is slightly wider behind than in front (in the described specimen it is spread more than normal). There are five spots on the lip, three radiating from eye in most of the specimens. These may be dim and scarcely discernible. A ventral discoidal disc is dimly evident in some individuals, terminating before high is reached.

The specimens were taken near Turrialba (No. 28253 Morehouse Finca, 4½ mi. south) and Los Diamantes, one mi. S Guápiles (Nos. 28252, 28254). They were obtained from bromelias and on the ground. The first finger of the male has a swelling at its base and on it minute asperities are visible under magnification. Several specimens were obtained at Moravia, at Bataan and others at Turrialba in 1951.

There is some variation in the size of the digital discs and much variation in color. One young specimen has narrow yellow-white lines following the canthus and broad lines of the same color from eye to groin; the upper part of arm is cream-white, and there is only one diagonal line on each side. Another specimen has the diagonal lines on sides of body continuous with lines crossing legs, when folded legs are pressed against body in the typical sitting posture. A third young differs from both of these, but all have more pigment on venter and under limbs than do adults, and in all it is equally distributed save in groin where, as in adults, there is no pigment.

Eleutherodactylus caryophyllaceus (Barbour)

Figure 19

Syrhopus caryophyllaceus Barbour, Proc. New England Zool. Club, vol. 10, March 2, 1928, p. 28, pl. 2, fig. 1 (type locality La Loma, on the trail from Chiriquicito to Boquete, Boca del Toro province, Panamá, in cloud forest; Dunn and Duryea, colls.).

Eleutherodactylus caryophyllaceus Dunn, Copeia, 1937, No. 3, p. 163 (La Hondura).

Diagnosis: This form may be diagnosed by its small size (23.2 mm.), by its generally yellowish or pinkish color in life, or in preservation, by the very slight amount of pigment scattered over the pinkish flesh color of body dorsally and ventrally; usually two tiny

black spots, present on median line of back, form the apices of two pairs of converging diagonal rows of dark pigment dots extending from sides; digits unwebbed, with small discs; snout much elongated, the canthi sharply distinct; limbs with narrow often very indistinct darker bars; sometimes dim, darker bars across snout.

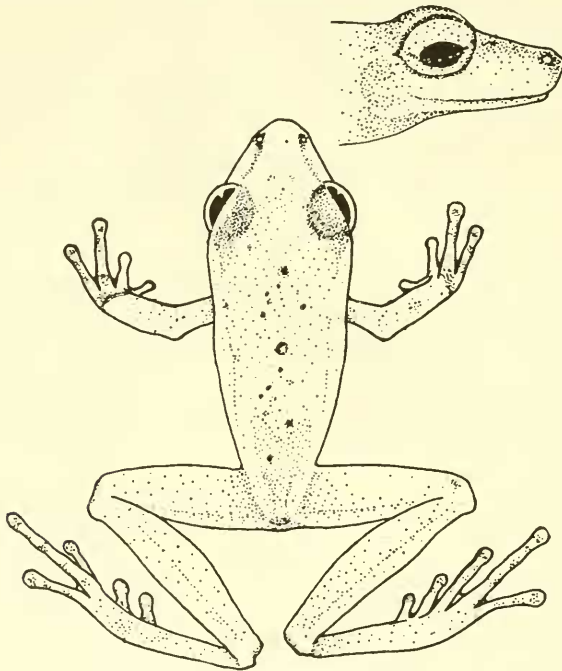


FIG. 19. *Eleutherodactylus caryophyllaceus* (Barbour). K.U.M.N.H. No. 28202; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 21 mm. (The tympanum is slightly more distinct than shown in the figure, and the digital discs are a little larger, the discs in the specimen having been slightly dessicated.)

Description of species: (From K.U.M.N.H. No. 28202.)—Head somewhat triangular, its length (8.3 mm.) distinctly greater than its width at jaw angles (6.9 mm.); eyes moderately large, the length of eye (2.7 mm.) equals its distance from nostril (2.7 mm.); top of snout very flat, in a single plane, the slight swellings about nostrils not causing any depression between nostrils; canthi distinct, appearing sharp, but actually slightly rounded; tip of snout extends considerably beyond nostrils and overhangs mouth .8 mm.; tympanum rather indistinct, irregular, its greatest diameter (in a paratype) is $1 \times .8$ mm., a little less than a third of eye length; loreal region not

or but very slightly concave, sloping straight down to lip; upper eyelid, 1.6 mm.; interorbital width, 2.5 mm.

Vomerine teeth one to three in minute fasciculi, not or scarcely elevated, situated between inner level of choanae but not reaching forward to their posterior level; choanae large, somewhat lateral, separated from each other by a distance equal to $3\frac{1}{2}$ times transverse diameter of one choana. Tongue longer than broad, with a small median emargination behind, free for half its length. (Vocal sacs present in males, the slits lying somewhat mediad, at a considerable distance from jaw.)

Skin generally smooth on dorsal surface of body, however a few minute tubercles present on side of snout under eye, around tympanum and on sides of body; a pair of tubercles on shoulders and a median one somewhat in front of these, marks the apex of an inverted V as they are connected with a dim line extending on sides; somewhat behind these is a median tubercle marking apex of two diagonal lines from groin that may have one or more tiny tubercles in evidence; abdomen granular, chin and breast smooth; under surface of thigh and region about vent with larger granules.

Arm short, the wrist fails to reach tip of snout; first finger distinctly shorter than second, all with symmetrical discs, first smallest, the fourth largest; subarticular tubercles rather indistinct; supernumerary tubercles scarcely discernible; an inner metacarpal tubercle on outer edge of base of first finger; the palmar tubercle large, partly divided.

Leg slender, the heel reaching halfway between nostril and eye; toes lacking webs, with small discs, symmetrical, or the fourth toe slightly asymmetrical; subarticular tubercles rather obscure; supernumerary tubercles present but indistinct; inner metatarsal tubercle large, distinct, its length nearly equal to length of toe beyond tubercle; outer metatarsal tubercle present; tarsus lacking both inner and outer folds or tubercles; a single well-defined tubercle on edge of eyelid, two on upper surface of arm and two or three on dorsal surface of femur.

Color: General color in life lively pink when captured, and after an hour or so it became yellow with scarcely a trace of pink. When first preserved the pink was again in evidence on back and sides, chin yellow, venter white, legs flesh-color with some pink on toes. After some days in formalin preservation, the specimen became flesh-white. There is a faint trace of a dark bar between eyes and two small brownish dusky dots on base of snout; dorsal

tubercles dusky edged; an indistinct dusky line along upper edge of loreal region; an inverted V-shaped mark on shoulders and a pair of lines from groin converging to a point on middle of back; limbs faintly barred with dusky; below flesh color, almost lacking pigment; eyeball, seen through lid, black.

Measurements in mm.: Snout to vent length, 21; head width, 6.9; head length, 8.3; eye length, 2.7; eye to nostril, 2.7; snout length, 4; arm, 11; hand, 4.8; leg, 31; tibia, 11; foot and tarsus, 13.

Remarks: I discovered the described specimen at Isla Bonita on the Caribbean slope of Volcán Poás (elevation 5000 ft.) in the leaf sheath of a fallen palm leaf. It was especially active and it was captured only after a hectic chase. The specimen agrees with two paratypes in the E. H. Taylor-H. M. Smith Collection in all essential detail.

A series of six specimens were captured at night at Moravia (K.U.M.N.H. Nos. 30861-30866). These varied from yellowish to olive-yellow with scarcely a trace of pink, the young being more distinctly yellow than the adults. One specimen was light orange-brown. The most unusual pattern is found in No. 30864. Here there are light unpigmented yellow lines from nostrils to eye along the canthi, continuing behind eye to groin. They are bordered above by dark lines that are connected across the shoulders and indistinctly connected across the middle of the back. All specimens with scattered pigment on venter.

Most of the specimens have the interorbital dark bar present; and No. 30861 has a small medial triangular cream spot between the shoulders. The largest specimen measures 23.2 mm. These specimens were found perched on low shrubs at night. I cannot be certain that I distinguished their call from those of other small eleutherodactylid forms.

Eleutherodactylus pardalis (Barbour)

Syrhopus pardalis Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, pp. 26-27, pl. 1, fig. 2 (type locality, La Loma, Panamá).

Diagnosis: "A wide-headed and slender-limbed species with large digital disks and silvery white spots on side and anterior aspect of thighs.

Description: "Nostril much nearer to tip of snout than to eye, the distance from the eye being slightly less than the latter's diameter; upper eyelids very little narrower than interorbital space; tympanum scarcely observable, about one third diameter of eye or slightly larger; disks of fingers and toes large and round; first

finger without disk, much shorter than second; fourth finger slightly longer than second; first toe very short, with a well developed disk; subarticular tubercles fairly well developed; plantar surface rugose; inner and outer metatarsal tubercles vestigial; hind limb being extended along the body, tibio-tarsal articulation reaches tip of snout; heels overlap considerably when hind limbs are folded vertically to body axis; skin above smooth; belly and posterior side of thighs granulate.

Color: "Very dark brown. Two or three large and conspicuous white spots on each side of abdomen. Three or four similar round conspicuous white spots on anterior aspect of thighs.

Measurements in mm.: "Tip of snout to vent, 25; width of head, 9.5; fore limb, 13.5; hind limb, 42; tibia, 14 mm."

Remarks: This specimen shows a resemblance in markings to *Eleutherodactylus altae* Dunn. It would appear that there are sufficient differences to separate them.

Eleutherodactylus altae Dunn

Figure 20

Eleutherodactylus altae Dunn, Notulae Naturae, No. 104, July 3, 1942, pp. 1-2 (type locality, Caribbean slope of Costa Rica, on the pass between Barba and Irazú below the divide and above the finca of Felix Delgado, approximately 4000 ft. elev.; colls. Dr. and Mrs. E. R. Dunn and F. Nevermann).

Diagnosis: A diminutive species, ♂ 21 mm. First finger shorter than second; fingers and toes without web, but with relatively large digital discs, those on outer fingers and toes asymmetrical; canthus more or less distinct; tongue shield-shaped free for half its length; vomerine teeth considerably behind posterior level of choanae; dark gray above, light grayish flesh below; a coral-red lateral stripe, and a coral-red stripe on anterior face of thigh; a white spot on posterior face of thigh; two such spots or three on the inferior face of tibia. Fifth toe larger than third.

Description of species: (From type specimen A.N.S.P. No. 23815 ♂.) A small species having a length of 21 mm. (20 mm. by present measurement); head length (8 mm.) equals head width; snout blunt, rather elevated, low; canthus distinct, rounded; area about nostrils distinctly swollen with a slight depression between; snout length a little greater than eye length; snout rounding in lateral profile, with a distinct labial notch; tympanum vertically oval (height 1.3 mm.; length, .9 mm.); eye-length, 3.3 mm.; eye to nostril, 2.2 mm.; nostril to median lip notch, 1.5 mm. Width of an eyelid (2.2 mm.) slightly less than interorbital interval (2.4 mm.); elevation of snout (greatest), 2.6 mm.; elevation at nostril, 2.1 mm.

Area about tympanum somewhat swollen; upper eyelid rough with some indistinct tubercles; a moderately prominent tubercle at jaw angle; the vocal sac rather circular reaching on breast; an indication of a breast fold (at least in male); the chin and vocal sac finely granular; loreal region not or but slightly concave, sloping obliquely to lip. Tongue shield-shaped emarginate on posterior edge, free for more than half its length; choanae small, lateral; vomerine teeth in two small fasciculi consisting of few teeth (the area has been scratched with a needle) situated mesially, distinctly behind choanae, not widely separated from each other; ostia pharyngea smaller than choanae.

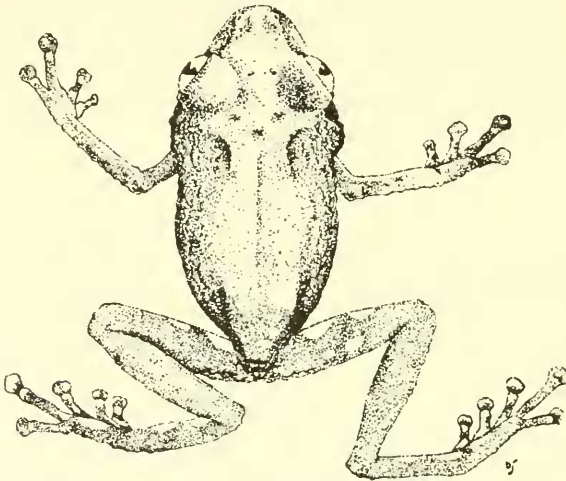


FIG. 20. *Eleutherodactylus altae* Dunn. K.U.M.N.H. No. 28171, Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 19.8 mm.

Arms short, the wrist barely reaching tip of snout. Digits bearing unequal sized discs, some asymmetrical; inner metacarpal tubercle elongate, oval, nearly equal to length first finger between disc and tubercle; outer tubercle somewhat bifid; supernumerary tubercles present; subarticular tubercles smooth, none divided; first finger shorter than second; no webs on fingers but trace of ridges on lateral edges of digits.

Heel reaches to middle of eye; when folded at right angles to body, heels touch but do not overlap. No trace of web on feet; subarticular tubercles on feet small, distinct; inner metatarsal tubercle large, flat, nearly equal to length of first toe; outer tubercle distinct, round; discs equally as large as those on fingers, and def-

initely asymmetrical, particularly those of the third and fourth toes; numerous supernumerary tubercles; indications of an inner tarsal tubercle near the inner metatarsal tubercle; a distinct tubercle on heel; fifth toe longer than third.

Skin smooth above with some tubercles on head; venter granular, as is about half area on ventral surface of thigh; granules below vent irregular, with an indistinct groove behind vent; inguinal gland rather inconspicuous.

Color: Dark gray on dorsal surface of body and head; lighter gray on under surfaces; a large elongate inguinal spot extending nearly half length of body and continuous with a similar elongate spot covering front of thigh (coral-red in life); two white spots on under surface of tibia and one on the front of the tarsus; a white spot on the posterior surface of thigh.

Measurements in mm. of Eleutherodactylus altae

	NUMBER	
	Type ♂	28171 ♀
Snout to vent	20	19.8
Width of head	8	9
Length of head	8	9
Length of snout	3.6	3
Length of eye	3.3	3.1
Arm	13.1	13
Hand	5.5	5.4
Leg	28.4	29.5
Tibia	10.3	10
Foot and tarsus	12.5	13

Variation: I obtained a single specimen (K.U.M.N.H. 28171) from a bromelia growing on a fallen branch at Isla Bonita, Volcán Poás. A second specimen in the same plant escaped. The species is especially active for its small size.

My specimen agrees with the type in most essential characters but a few differences are in evidence, and there is some difference in the details of the color. The inner metacarpal tubercle is somewhat shorter and the outer metacarpal tubercle is more distinct and divided for a greater distance. The inner metatarsal tubercle is slightly shorter, proportionally. The toe discs on the two outer toes actually are a little larger than those on the two outer fingers.

Some other characters evident in my specimen (female) that are less evident in the type are: tongue relatively very large, broadened behind, narrowed anteriorly, emarginate posteriorly, free for three fourths of its length. The vomerine teeth in two somewhat longitudinal groups, beginning anterior to the posterior level of choanae,

extend behind it for some distance. Choanae rather large, nearly lateral, half-moon shaped, their greatest length in distance between them, approximately 2.8 times. A ventral discoidal disc present with the folds on side distinct anteriorly, but posteriorly indistinct so that it is impossible to say whether they terminate in front of thigh or not.

Leg short, the heel reaching anterior edge of eye when brought forward; fifth toe reaches farther forward than third; no trace of an inner tarsal fold; two or three tubercles along outer edge of tarsus representing a remnant of an outer tarsal fold. Nostrils separated by a distance greater than their distance from the deep notch in upper lip; but smaller than their distance to eye. There are more or less distinct curved canthii behind occiput, and five symmetrically arranged tubercles on the head and occiput (see figure).

The color in life is generally blackish above and along the sides; below somewhat lighter but heavily pigmented with brownish black; chin lighter, the pigment (under lens) is seen to be flecked and reticulated with lighter color; three or four very small reddish flecks on both upper and lower lip; a large red-orange spot in front of elbow joint; and a large axillary red-orange spot; a large red-orange area in groin in contact with (or narrowly separated from) a large rounded spot of same color on the anterior face of femur; three other rounded smaller spots on same side of femur; posterior face of femur black, each with a red-orange spot and a white spot; under surface of tibia with numerous white spots, some partly fused together; dorsoanterior surface of tarsus and inner toes with white spots.

Remarks: One other species that I know only from description suggests relationship to this species. This is *Syrrhophus pardalis* Barbour^o. From *pardalis* it is presumed that *altae* differs in the presence of vomerine teeth (not mentioned but placed in a genus usually lacking these teeth); it differs in having deep coral-red or red-orange colored spots rather than silvery white spots (possibly faded?), in the asymmetry of the discs of the outer fingers and toes (in *pardalis* they are "round"); in the shorter limb, (in *pardalis* the heel reaches tip of snout); in the failure of the heels to overlap when limbs are folded† (overlap considerably in *pardalis*). This species measures as follows: length, 25 mm.; head width, 9.5 mm.; arm, 13.5 mm.; leg, 42 mm.; tibia, 14 mm.

The measurements of *S. pardalis* show interesting differences;

^o *Syrrhopus* (*sic*) *pardalis* Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, pp. 26-27, pl. 1, fig. 2.

† Barbour mentions *Tomodactylus simulac* (*sic*) Günther in comparison. *Tomodactylus amulae* is intended—a very different species as he suggests.

altae has a snout-vent length of 20 mm., *pardalis* 25 mm. The arm in both forms is practically the same, 13.1 and 13.5; however the leg in *altae* (in female) is 29.5, in *pardalis*, 42.

The tympanum is slightly more distinct than is shown in the figure, and the terminal discs of outer digits are somewhat more expanded than shown, since on this specimen they have been somewhat desiccated.

Eleutherodactylus diastema (Cope)

Lithodytes diastema Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 155-156 (type locality, "Camp Mary Caretta," Panamá); Proc. Amer. Philos. Soc. 1886, vol. 23, p. 274 (Nicaragua); U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Hylodes diastema Boulenger, Catalogue of the Batrachia Saliencia s. Ecaudata in the collection of the British Museum, ed. 2, 1882, p. 212; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, p. 238; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 432-433.

Hyla chica Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, June 20, 1918, pp. 335-339, pl. 18, text figs. 3-6.

Eleutherodactylus diastemma (*sic*) Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 32, 1921, p. 161 (Costa Rica).

Eleutherodactylus diastema Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, pp. 411-412.

Syrnhopus ineptus Barbour, Proc. New England Zool. Club, vol. 10, 1928, pp. 25-26, pl. 1, fig. 1. (I have examined the type [MCZ. No. 13050]. The pads on the toes shown as being minute in the figure actually are larger).

Diagnosis: This form may be diagnosed by the following: diminutive hylalike frogs (maximum size for females 24 mm., of males 20 mm.); the skin smooth or occasionally with some scattered small tubercles on sides of head or body; tympanum diameter nearly half length of eye; fingers and toes with relatively large discs, without a trace of web, the two outer toes seem more closely bound together at the basal metatarsals than are the other toes and the outer toe seems to arise from a point farther forward than the third toe; tubercles under hand and foot rather indistinct; vocal sac and vocal slits in male.

Description of species: (From K.U.M.N.H. No. 24981 ♀.) Head rather oval, moderately rounded, with the canthus rostralis rounded; eye large, as long as the snout; nostrils lateral, area about them slightly swollen; tip of snout bearing a minute point or "nose" (not invariably discernible); tympanum distinct its diameter a little more than one third length of eye, loreal region sloping to lip not concave; tongue large, broadly rounded behind (not emarginate), greatly narrowed in front (greatest length, 6 mm.; greatest posterior width, 4 mm., anterior width, 1 mm.); tongue free for more than half of its length and free at sides; opening of Eustachian tubes small, about one third size of small choanae; choanae rather

widely separated, somewhat lateral in position, partially hidden when seen from below, by shelf from maxillary; small vomerine elevations, without vomerine teeth.

Skin generally smooth but a few small tubercles on eyelid and behind jaw angle; rather granular low on sides, while the venter itself has a suggestion of granulation posteriorly; median part of underside of thighs distinctly granular or areolate; only a faint trace of a supratympanic fold; under lens one may discern fine vermiform folds or corrugation.

Arm short, the wrist reaches the tip of snout; hand short; discs broad, the largest a little smaller than tympanum, the width of largest (1.2 mm.) double width of finger (.51 mm.); first finger shorter than second; subarticular tubercles small, rather flattened not especially distinct; an inner palmar tubercle lateral to base of first finger; a larger median palmar tubercle (may be partially divided); a few small indistinct supernumerary tubercles.

Heel to back part of eye when brought forward; largest discs on toes equal to those on fingers; fifth toe bound more tightly to fourth at base than third; fifth reaches farther forward than the third; no web present on either hand or foot; subarticular and supernumerary tubercles small rather indistinct; outer metatarsal tubercle a little smaller than inner but relatively more elevated and distinct; tarsal tubercle or fold indistinct or wanting.

Color (in life): "Light flesh above, below with a pink wash on thighs and legs; toes salmon."

In alcohol the general color is brownish gray with a faint trace of a median line; below light flesh; under a lens one discerns slightly more pigment on the dorsal surface; the pigment is equally but sparsely scattered over the entire under surfaces including palms and soles; there is faint indication of two rather short lateral lighter lines on sides of back.

Measurements in mm.: Snout to vent, 23.9; width of head, 8.8; length of head, 8.4; length of eye, 3.2; tympanum, 1.15; length of snout, 3; arm, 15; hand, 5.5; leg, 29; tibia, 10; foot and tarsus, 13.

Variation: Males have a large vocal sac, lemon yellow in color; the vocal slits are rather posterior in position. The vomerine elevations are usually visible as two flattened slightly raised areas considerably behind but between inner levels of choanae; the presence of teeth can sometimes be discovered by a needle, even when not appearing above the gums.

Distribution: Specimens were taken at Cervantes and at Isla Bonita in bromelias. None were discovered by hearing them call.

At Los Diamantes however practically all the specimens discovered were calling from low trees at night. Specimens were taken near Empalme and in the National Forest. The species has been reported from Nicaragua to Panamá.

Remarks: This tiny frog, its maximum snout-to-vent length only 24 mm., is commonly found in bromelias, from the lowlands up to an elevation of about 5500 feet. Specimens taken in the daytime from such places are usually brownish often rather dark brown, sometimes with longitudinal lighter lateral lines, sometimes with little or no pattern evident save for two short, lighter lines along the sides of the back. Those taken at Los Diamantes at night calling from branches of low trees and shrubs had a well-defined black pattern on a grayish ground color. These forms differ somewhat from typical specimens from higher elevation so that they may merit subspecific designation. The pads on the toes are a trifle larger, the snout is observably narrower and the toes are free a greater length. The call is a short whistle.

Eleutherodactylus cerasinus (Cope)

Figure 21

Hylodes cerasinus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 112-113, pl. 26, fig. 4 (type locality, eastern slope, Pico Blanco, Costa Rica; W. Gabb, coll.); Brocchi, Mission Scientifique au Mexique et dans l'Amérique centrale; Étude des Batraciens de l'Amérique centrale, livr. 2, 1882, pp. 57-58; Boulenger, Catalogue of the Batrachia Saliencia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 216; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 15. Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug., 1900, p. 231 (*part.*). (The specimen from La Palma, Costa Rica, is probably not of this species); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 437-438 (*part.*).

♀ *Eleutherodactylus cerasinus* Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, 1921, p. 161 (Zent).

Eleutherodactylus cerasinus Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, p. 411 (Gatun, Canal Zone; Costa Rica).

Diagnosis: A vocal sac present in male; venter very strongly granular; diameter of tympanum one third length of eye; no trace of webs on digits; W-shaped fold or ridge outlined on back of occiput; discs large, distinctly larger than tympanum, equal to half diameter of eye; area behind eye and tympanum rugose.

Description of the species: (From K.U.M.N.H. No 28343.) Head as wide as body, oval in outline; snout much narrowed; canthus rostralis distinct, somewhat rounded, terminating at the swollen area above nostril; a slightly depressed area between nostrils and at tip of snout; latter reaches beyond the line of the mouth 1 millimeter; canthal region not or scarcely concave, sloping very obliquely to lip; eye moderately large; its length (4.2 mm.) about equal to its distance from the nostril (4.1 mm.); length of snout 5.4 mm.; tym-

panum moderate, a little higher than wide (♀), 1.6 mm. in greatest diameter, more than one third length eye; a heavy warty supratympanic fold, tending to obscure upper border of tympanum, forms an angle rather than a curve as it passes down behind tympanum; two large pyramidal tubercles slightly below and behind tympanum.

Vomerine teeth in two very small, slightly elevated fasciculi, well separated mesially, lying within the inner level of choanae, but con-



FIG. 21. *Eleutherodactylus cerasinus* (Cope). K.U. M.N.H. No. 28343; Morehouse Finca, 5 mi. SW Turrialba, Costa Rica; snout-to-vent length, 33 mm.

siderably behind them; choanae about equal in size to opening of Eustachian tubes; tongue oval, cordiform, notched slightly behind, free for nearly half its length. (Males with vocal sac and distinct vocal slits.)

Arm moderately long, the wrist reaching beyond tip of snout; first finger smaller and shorter than second, its disc only slightly wider than digit, those of two outer fingers largest (1.8 mm. wide), much larger than tympanum; subarticular tubercles rather large, distinct; supernumerary tubercles on palm moderately distinct; unequal in size; inner metacarpal tubercle oval; outer palmar tubercle large, more or less completely divided, the inner part largest; four or five distinct tubercles in a row under arm; dorsal surface of fingers and hand with some smooth indistinct tubercles.

Heel reaches to a point between eye and nostril but nearer the latter; toes long, completely free, the metatarsals of the outer two closely bound together; discs large but not reaching size of discs on outer fingers, that on first toe smallest; a large projecting inner metatarsal tubercle; outer present but small; supernumerary tubercles present; subarticular tubercles distinct; a fairly distinct tuberclelike swelling immediately behind discs on both hands and feet; no trace of a web.

Skin above generally smooth with some minute granules in loreal region and behind eye; area about tympanum with small granules and larger tubercles; a supratympanic fold and a fold from back of orbit following the slightly elevated area of occiput, terminating on shoulders in an elongate tubercle; behind these and somewhat wider apart, another pair of tubercles; a single median tubercle in middle of occiput; axillary region and anterior two thirds of sides nearly uniformly granular; groin and under surface of femur and tibia smooth; chin and breast completely smooth; belly strongly and regularly granular; about half of median ventral portion of thighs and an area in anal region granular; posterior part of thigh smooth; a few low ridges follow the dim dark marks on tibia.

Color (in life): Generally yellowish clay, somewhat variegated above; head blackish, the sides similar to back, but becoming pink in smooth area of groin and anterior face of femur for half its length.

Posterior part of femur and part of tibia deep red; fingers whitish; legs olive, with dark olive-gray bars. Throat, breast and venter whitish with some very indistinct dusky shading; back part of rump a little dusky; limb bars dim; some dusky spots below eye; tip of snout dark; considerable pigment on under surface of foot, less under hand.

Measurements in mm. of Eleutherodactylus cerasinus

	Collection	K.U.M.N.H.	K.U.M.N.H.	R.C.T.	U.S.N.M.
Sex	}	♀	♀	♂	
Number		28343	28342	538	32572
Snout to vent		33	32	21	35
Head length		14	14	8	13
Head width		12.7	12.2	7.9	13
Snout		5.4	5.4	4	..
Eye length		4.2	4.3	3.2	..
Greatest diameter of tympanum		1.6	1.6	1.1	..
Arm		19	18.2	11	22
Hand		8.5	9	5.3	9
Leg		50	50.2	34	55
Tibia		17	17.6	12.5	..
Foot and tarsus		22.8	23.2	15	24

Nos. 28342-28343, 538 Morehouse Finca, 5 mi. S Turrialba.

Variation: The colors vary somewhat, age presumably being a factor. In No. R.C.T. 357 the general color is yellow-brown above, and the reddish marks of groin and thigh are less distinct. There is no red present on tibia. The lighter areas on the sides are yellow or yellow-olive, while the head generally is darker. In R.C.T. No. 386, the specimen is "pinkish-brown above, whitish below; a pink spot on thigh." R.C.T. No. 356 "has a light, clay-colored, median stripe from occiput to groin."

In the preserved specimens the sides of the shoulders are darker and there are some dark spots on lips and a suggestion of a dark line along the edge of the canthus and tip of snout, a dark mark between orbits and one on base of snout. A pair of black tubercles may be present on the posterior part of the rump. In younger specimens the tubercles and folds are less distinctly marked. The males are very much smaller than females, the largest of several fully adult males being only 21 mm. These differ from females in the character of the first finger (bearing two groups of nuptial glands), and the tympanum is but little larger proportionally than it is in the females. A young male specimen (R.C.T. No. 385) has a pair of curving light lines beginning behind the eye and meeting on the middle line of the body, then continuing to the rump. On each side bordering this from the eye, is a black stripe. There is a deep-black median spot on occiput, an interorbital bar, a dark mark on the snout, darker lines on the upper edge of the canthi and several dark spots on the upper lip. The limbs are very distinctly barred.

The type specimen of *cerasinus* (U.S.N.M. No. 32572) is old and soft. Characteristic folds and tubercles of the skin are absent, and many characters cannot be determined. The heel reaches to a point just in front of the eye. The length of the eye (3.6 mm.) is about 3 times the tympanum (1.25 mm.). The specimen has no vocal slits but may be a female. There is a faint suggestion of web between first three toes which may be due to the condition of the specimen. The choanae are large, the anterior edge elevated (hangs down); vomerine tooth fasciculi elongate, triangular, much behind choanae but beginning anterior to their posterior edge.

The species was taken on the ground, at Morehouse Finca near Turrialba and at Boquete Camp, west slope of Cerro de la Muerte at approximately 2000 meters elevation. The type locality is on the eastern slope of Pico Blanco in southern Costa Rica. Dunn has reported the species at Zent, Costa Rica, from near sea level.

Eleutherodactylus dubitus sp. nov.

Figure 22

Type: K.U.M.N.H. No. 24942, Isla Bonita, (American Cinchona Plantation), Volcán Poás, southeastern slope, elev. 5500 ft.

Paratypes: K.U.M.N.H. Nos. 24910-24948. R.C.T. No. 1981, lot number for 53 specimens. All topotypes.

Diagnosis: Maximum size of female 38 mm., maximum of males 25 mm.; males without vocal sacs or vocal slits; fingers and toes without webs, long, slender, the discs twice or more the width of digits; tympanum minute about $\frac{1}{6}$ diameter of eye; probably less than one twelfth of the area of the eye; venter and throat (usually) finely granular; color and markings variable.

Description of species: (From K.U.M.N.H. No. 24942). Width of head (15.2 mm.) approximately equal to its length (15.1 mm.); canthus distinct, rounded on edge; area about nostrils swollen but there is no noticeable depression between them; eye moderately large, protuberant, the length of eye (4.9 mm.) less than length of snout (6.2 mm.); nostrils much nearer median notch in upper lip



FIG. 22. *Eleutherodactylus dubitus* sp. nov. Type. K.U.M.N.H. No. 24942; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 35.5 mm.

than to the eye; tympanum small, its diameter (1 mm.) approximately one fifth length of eye; width of an upper eyelid equal the interorbital width; tongue longer than wide, free for nearly half its length, not minutely emarginate behind; vomerine teeth in two transverse raised fasciculi each larger than a choanae, and separated from each other by a space nearly equal to width of one group; they lie considerably behind, but between the level of inner margin of choanae.

Skin smooth on dorsal surface with numerous smooth tubercles or small pustules on sides, especially in axillary regions and side of head near jaw angle; a tubercle between eyes; an indistinct W-shaped ridge marks a more elevated area on occiput; a slight supratympanic fold curves down to arm. Arms with large rounded tubercles on outer side; underside of thighs and venter uniformly granular, the chin only indistinctly granular.

Arm long, the wrist reaching considerably beyond snout tip; fingers free of web, long, slender, with discs, that on first smallest, those on third and fourth largest, nearly equal, the width (2.8 mm.) more than half length of eye; subarticular tubercles present, distinct; supernumerary tubercles on palm; a moderately large inner palmar tubercle at base of first finger; a bifid or tripartite median palmar tubercle; an indistinct row of tubercles under forearm; leg rather short the heel reaching slightly in front of eye; fingers long with a suggestion of narrow lateral ridges on each side of digits; terminal discs large but scarcely reaching size of those on fingers; metatarsals of two outer toes strongly united, the fifth toe extending beyond third. Small subarticular tubercles as well as supernumerary tubercles present on sole; a large inner metatarsal tubercle nearly half as long as first toe; outer tubercle small; a short metatarsal ridge from inner tubercle onto metatarsus ending in a tubercle; when legs are folded heels touch or minutely overlap.

Color: Ground color gray with dusky darker flecks and reticulations, the lateral folds of the W pattern edged with a narrow blackish line; some dorsolateral spots with diffused pigment; limbs very dimly barred, the lower part of posterior face of femur uniform brown away from anal area; below whitish with a fine dim reticulation of dusky; chin and breast lighter but with fine pigment; marks on side of head obsolete; a light area on heels; inner fingers light colored.

Measurements in mm. of Eleutherodactylus dubitus sp. nov.

	TYPE	24942 ♀	24933 ♀	24922 ♀	24913 ♂	24948 ♂	24918 ♂
Snout to vent	35	37.5	36	35.5	25	24	23
Head width	13	15.2	14.6	14.9	9.8	9.8	9.8
Head length	13	15.1	14	14	10	10	10
Arm	22	25	25	25	17	17	16
Hand	9	11	11	11	9	7.3	7.4
Leg	55	65	56	55	39	38.3	37
Tibia	17	17	18	18	13	12.8	12.6
Foot and tarsus	24	26	26	26	19	18.6	17

All numbered specimens from Isla Bonita, Costa Rica.

Variation: In this species there are several color patterns that are found occasionally so different as to make the beholder question whether the forms are the same. A few of the more striking types of pattern are listed.

1. The general pattern delineated above is characteristic of approximately 81 per cent of the specimens examined. There is, however, some variation in pattern, often a distinct lighter area appearing on the occiput. This is characteristic of both sexes.

2. A nearly uniform brownish black or blackish brown above with some slightly lighter areas sometimes visible; the venter is brown—the pigment heavy, the sides having large blackish spots with lighter interspaces. In life these may display some pink or reddish coloration in the thigh area or groin. This type of color occurs in both sexes. These constitute approximately ten per cent of the specimens.

3. In both dark and light forms the top of head and body is uniform clay-color; in lighter forms the sides are spotted. Six of these specimens have been seen, one clasping a female of the first group.

4. In these the body is relatively dark save for a symmetrical light clay-colored area beginning on snout and extending back on the elevated part of head bounded by the W-shaped folds. The light spot has two tiny symmetrical dark markings near the back of the head.

5. A median light stripe extends the length of the body. There is a tendency for the pigment to become arranged so as to show two darker stripes one on each side of the light stripe; three of the four specimens so marked are light, one is of the dark phase.

6. One very young specimen has two broad dorsolateral stripes. This specimen was taken at Cervantes.

Specimens for the most part were taken at night with the aid of a light. The males were calling from small shrubs or from the road-

cuts. It was, perhaps, the most common species at Isla Bonita during my visit there in 1947. Males are especially small compared with the females.

I cannot agree that this species should be referred to *Eleutherodactylus latidiscus*. This latter species, while agreeing in certain characters, i. e. the absence of the vocal sac, in the males, is a much larger species reaching a snout-to-vent length of 52 mm.; the ventral skin is smooth rather than granulate; and the tympanum is very much larger, one third to two fifths diameter of eye. The largest Costa Rican specimen of *dubitus* (female) in the large series available to me is only 38 mm. Any close relationship to *Eleutherodactylus ventrimarmoratus* is likewise doubtful. Here again the name applies to a species having a smooth venter. The marking of dorsum and thighs is distinctly different, and the tympanum is larger. I would suspect that *E. ventrimarmoratus* is more closely related to *Eleutherodactylus ceresinus* than to the form here described. (See Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 8, 1933, pp. 68-69.)

Eleutherodactylus noblei Barbour and Dunn

Figure 23

Eleutherodactylus noblei Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Dec. 21, 1921, pp. 161-162 (type locality Guápiles, Costa Rica, Dunn coll.).

This species perhaps doubtfully separable from *Eleutherodactylus lanciformis* (Cope) is represented by three specimens in the material at hand; two smaller examples are from Guápiles, the type locality for *noblei*, and one, a large adult, is from near Turrialba.

Diagnosis: A purplish-black stripe on side of head from tip of snout crosses tympanum, and continues, much narrowed, to middle of side; canthus distinct, rounded; no folds or distinct tubercles on body, except a straight dorsolateral fold from eye above tympanum continued to near groin, with a short diagonal branch running down behind tympanum; venter and throat smooth, the belly with a broad strongly defined discoidal fold; a sharply defined tarsal fold; legs long, heel extending several millimeters beyond tip of snout; hands without webs; some trace of webs on feet.

Description of species: (From K.U.M.N.H. No. 28172, Turrialba, C. R.) Head broader than body, its width (25.5 mm.) minutely greater than length (25 mm.); eye proportionally small, its length (6.2 mm.) approximately half length of snout (12 mm.); tympanum large, vertically oval, placed slightly diagonally (5.3 mm. x 3.6

mm.), separated from eye by a distance of 3.6 mm.; canthus distinct, rounded, but due to the sharp delineation of dorsal and lateral color it appears angular; area about nostril slightly swollen, the nostrils not terminal, 8 mm. from eye, 3 mm. from tip of snout and 5.2 mm. from median notch in upper lip; snout projecting beyond mouth 3 mm.; width of an upper eyelid (5.3 mm.) much less than inter-

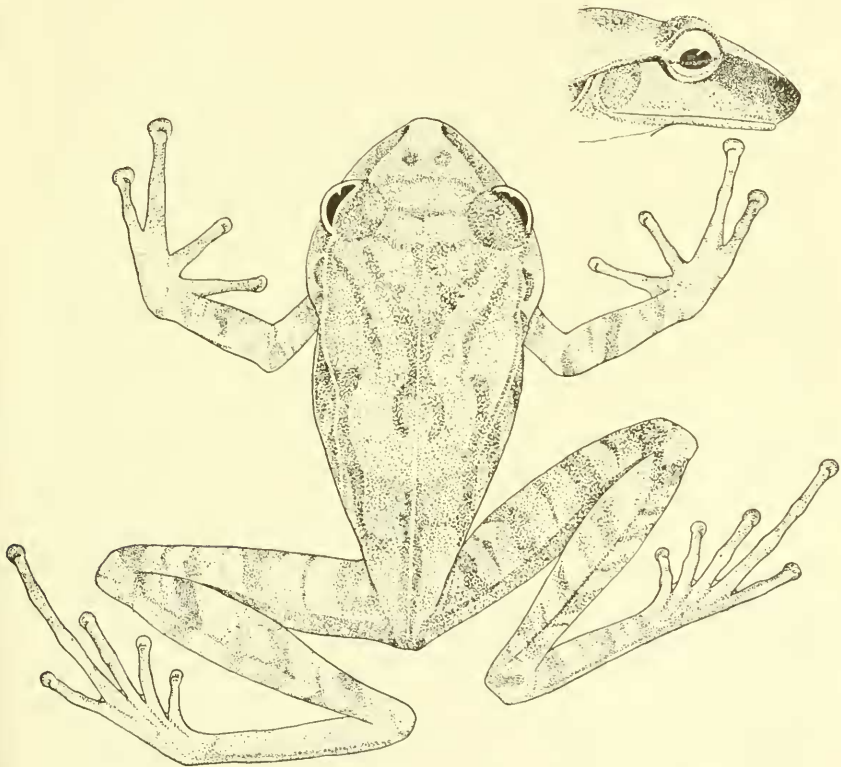


FIG. 23. *Eleutherodactylus noblei* Barbour and Dunn. K.U.M.N.H. No. 28172; Turrialba, Costa Rica; snout-to-vent length, 60 mm.

orbital width (8.3 mm.); loreal region slightly concave, nearly vertical, the lower part sloping obliquely to lip.

Vomerine teeth in two series on triangular elevations between choanae and anterior to their posterior level, each series smaller than a choana; choanae lateral, when seen from below appearing oval; tongue longer than wide, a little wider posteriorly than anteriorly, distinctly emarginate behind, and free behind for one third of its length.

Arm long, wrist extending half length of forearm beyond snout; no webs on digits of hand; first finger longer than second, each with a narrow terminal disc; two outer fingers with discs at least one and one-half times larger; subarticular tubercles oval, moderately prominent; supernumerary tubercles indicated but indistinct; inner metacarpal tubercle oval, elongate, at base of first finger; median palmar tubercle a large pad, partly divided; no fold or tubercles on under surface of arm; leg long, the heel reaching about 8 mm. beyond tip of snout; heels overlap 8 mm. when legs are folded at right angles to body; a sharply defined, continuous, tarsal fold more than half length of tarsus; discs of toes smaller than those on fingers, that of first and fifth smaller than the other three, fourth largest, all more or less asymmetrical; subarticular tubercles prominent; five supernumerary tubercles on sole; inner metatarsal tubercle oval, elevated, more than a third length of first toe; outer tubercle small, distinct; third and fifth toes reach forward equal distances or the third slightly the longer; a small remnant of a web between the first and second toes extending as a very narrow fringe nearly half length of second; between second and third a still larger remnant, but web barely indicated between the third, fourth, and fifth; dorsal surface finely shagreened or granular; sides of body minutely but smoothly granular; a considerable part of under side of thigh granular, as is also anal area and to a lesser extent inner ventral part of thigh; the supratympanic fold, with a posttympanic branch, continues as a skin fold along side of body to groin; chin and venter smooth or transversely wrinkled, the ventral abdominal "disc" sharply outlined by a discoidal fold.

Color: Dorsal surfaces generally grayish mauve or lavender with a pair of curving stripes arising above tympanum, curving back to near the median dorsal line, then diverging slightly before they terminate; on the sacrum a pair of dorsolateral stripes begin back of shoulders and continue to groin; a moderately distinct darker bar across head in interorbital region preceded and followed by a similar but curving line; a pair of rounded dusky spots on middle of snout; arms and legs dimly barred with light brown, the lines curving somewhat or assuming the character of chevrons on the tibia; between these bars, very narrow intervening lines visible; posterior face of thigh uniformly dusky with minute flecks and lighter reticulations; darker lavender on under surface of tarsi and feet; entire venter and chin white with very slight pigmentation on chin; under side of hand nearly white; a hair-fine median dorsal

line. In life the general ground color is yellowish or yellowish brown with a pinkish wash on sides, on front of thigh, and on lighter parts of limbs.

Measurements in mm. of Eleutherodactylus noblei

Number collection	28172 ♀	2077 ♀	1563 ♀	Type
	K.U.	R.C.T.	R.C.T.	
Snout to vent	60	37	30	60
Head width	25.5	15.2	11.9	....
Head length	25	15.5	12.5	....
Snout (to eye)	12	7.6	5.8	....
Length of eye	6.2	4.6	4	....
Arm	44	24.5	17	....
Hand	19	12	9.5	....
Leg	114	69	49	105
Tibia	38.8	24	17.2	....
Foot and tarsus	50	31	22	....

Variation: The type is described as having a body wider than head, with the tibiotarsal articulation reaching nostril. The first difference is probably not significant in an adult female since the specimen I describe, if it were gravid, might well have a body broader than the head.

In the smallest topotypic specimen (No. 1563) the heel reaches the tip of the snout; the somewhat larger specimen (No. 2077) has the heel reaching five millimeters beyond the snout. The specimen described is from Turrialba; the others are from Los Diamantes, near Guápiles.

I have considered the possibility that *Eleutherodactylus noblei* might be a synonym of *Hylodes fitzingeri* O. Schmidt. The description of the latter is very brief and omits mention of many characters and proportions. Among the characters of *fitzingeri* mentioned by Schmidt that are not applicable to *noblei* are: very slender body; a white line around tip of snout and on to jaw (rather than a broad purple line of *noblei*), and proportionally longer leg; there is shown on the Schmidt figure (plate I, fig. 10), that the web-remnant reaches to or beyond the level of the basal subarticular tubercles. No mention is made of the dorsolateral fold from eye to side or the presence of a strong inner tarsal fold. *E. noblei* is a lowland form reaching a known elevation of 2000 ft.; *E. fitzingeri* is from 4000 ft. elevation.

Dunn^o has described *Eleutherodactylus breederi* from Darien, said to be related both to *noblei* and *gollmeri*.

^o Dunn, Amer. Mus. Novitates No. 747, 1934, pp. 1-2.

Eleutherodactylus gollmeri (Peters)

Figure 24

- Hylodes gollmeri* Peters, Monatsb. Akad. Wis. Berlin, 1863, p. 409 (type locality, Caracas, Venezuela, Gollmer coll. 2 specimens); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2 ed., 1882, p. 205 (Quito, Perú, and Sarayacú, Ecuador); Proc. Zool. Soc. London, vol. 2, Oct. 1, 1903, p. 69 (Chapadá, Matto Grosso, Brazil); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 464.
- Hylodes güntneri* Steindachner, Verh. Ges. Wien, vol. 14, 1864, p. 246, pl. 17, fig. 1, la. (type locality, Brazil).
- Eleutherodactylus gollmeri* Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, 1932, p. 24 (places *rostralis* Werner, *humeralis* Fowler, and *goldmani* Noble in synonymy); Occ. Papers Boston Soc. Nat. Hist., vol. 8, June 7, 1933, p. 67 (El Valle de Anton, Panamá.).
- Lithodytes lanciformis* Cope, Proc. Amer. Philos. Soc., 1877, p. 88 (type locality "West coast of Central America").
- Hylodes lanciformis* Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude sur les Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 55; Boulenger, Catalogue of the Batrachia Salientia. . . . 1882, p. 202; Güntner, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, p. 239; Nieden, Des Tierreich, Lief. 46, Anura I, 1923, p. 429; Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, 1921, pp. 161-162 (Navarro and Guápiles, Costa Rica).

Diagnosis: Medium-sized terrestrial frogs, maximum snout-to-vent length approximately 40 mm.; scarcely any sexual differentiation in size; snout rather narrow, the canthus sharply defined; a purplish black stripe from tip of snout covering side of head and to a point low on side; no vocal sac in male; a pair of black tubercles behind shoulders; subarticular tubercles large; small finger discs, larger ones on toes, all somewhat pointed with a tiny web remnant on foot.

Description of species: (From K.U.M.N.H. No. 30874, Moravia, Costa Rica.) Medium species (33 mm.) the snout rather bluntly pointed, oval; canthus distinct, the lines of canthi converging toward nostrils, then widening at nostrils; top of head and snout flattened somewhat without depression between nostrils; area about nostrils swollen slightly laterally; line of canthus continuous with thickened line bordering upper eyelid; tympanum large, edges elevated, 2.2 mm. wide, 2.5 mm. high; distance between tympanum and eye, 1.8 mm.; length of eye opening (4 mm.) equal to distance between eye and nostril (4 mm.); length of snout, 6 mm.; width of an eyelid (3 mm.), less than interorbital width (4.2 mm.); loreal region not concave, sloping regularly from canthus to lip; tongue slightly longer than wide, not or but slightly nicked behind; vomerine teeth in two raised fasciculi lying between inner levels of choanae but not reaching their posterior levels, separated from each other by half width of one fasciculus, and from the choanae by width of a fasciculus; ostia pharyngea triangular, but equally as large as choanae; (male without vocal sacs).

Arm short, the wrist reaches to tip of snout; first finger longer than second; no web between fingers; discs present but those on two inner fingers not wider than digits; outer somewhat wider, all more or less pointed at tips; subarticular tubercles prominent (less so than in *rhodopis*); six supernumerary tubercles on bases of fingers and palm; a prominent rather elongate inner metacarpal tubercle; palmar tubercle large, bifid, the outer part half size of inner part; several elongate tubercles under arm forming a broken ridge or fold; no webs on fingers but a ridge along inner edge of inner fingers.

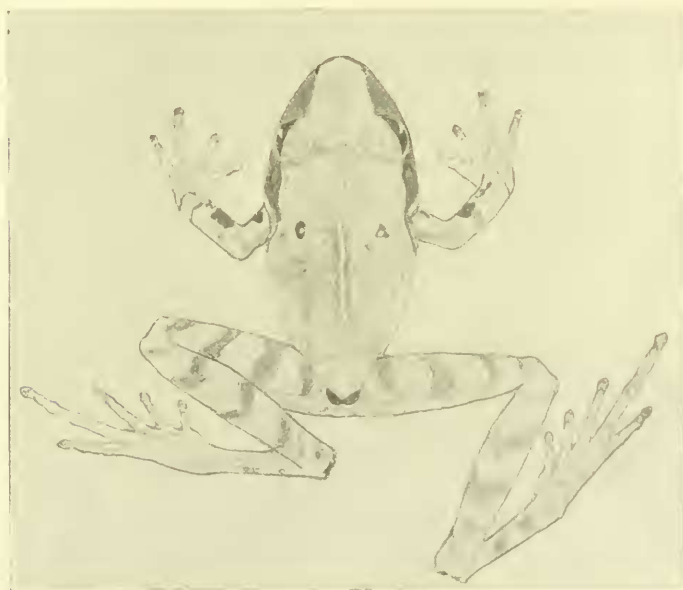


FIG. 24. *Eleutherodactylus gollmeri* (Peters). K.U.M.N.H. No. 30874 Moravia, Costa Rica. Actual snout-to-vent length, 33 mm.

Leg very long, the leg brought forward, the heel reaches 6.5 mm. beyond tip of snout; when legs are folded, the heels overlap 5.5 mm.; toe discs larger than those on fingers, all more or less pointed; a web remnant between three inner toes, continued along inner edges of toes as a narrow fringe or ridge; a distinct, rather prominent, inner metatarsal tubercle; a small but distinct conical outer tubercle; a strongly defined inner tarsal fold along distal half of tarsus; a ridge along outer edge of fifth toe more or less continuous along outer edge of tarsus as a series of indistinct tubercles; third and fifth toes reach forward nearly an equal distance.

Skin above on dorsum, head and limbs, with some minute granulation and some somewhat larger tubercles; eyelid with small tubercles; a pair of larger tubercles (usually black) on dorsum behind level of arm insertions; thickened edge of eyelid continuous with a small but sharply defined supratympanic fold which terminates a little behind level of arm insertion; a curving supratympanic ridge visible in front and behind tympanum but coinciding with the fold above the tympanum; chin, breast, and venter smooth; some granulation on under and posterior part of thigh; a strong heel tubercle; a ventral disc outlined by a narrow fold terminating some distance in front of thighs; no inguinal gland discernible.

Color: Above brownish, with a dim darker pattern; head light brown above, black laterally; lines of canthi lighter, continued forward to lip as two narrow white lines; behind eye the whitish line follows above the black and terminates low on side behind arm insertion; a hair-fine median cream line; a dark triangular spot on occiput beginning between eyes; some dim diagonal lines on sides; a dim bar crossing rump; limbs strongly barred with darker brown and edged with lighter, the marks continuous when legs are folded, those on tibia arranged as chevrons; a black spot on each forearm, on thighs near knees, two at vent; blackish on underside of tarsus and foot, and a line on under surface of tibia; chin and venter cream to flesh-white, front of thighs somewhat pinkish; a fine scattering of pigment on chin; venter free of pigment.

Measurements in mm.: Snout to vent, 33; width of head, 14; length of head, from jaw angle, 15; length of arm, 22; leg, 69; tibia, 23; foot and tarsus, 34.

Variation: There is considerable variation in the darkness and lightness of the ground colors. Some specimens are light gray to fawn or clay, others deep brown; the dark color on the side of head (loreal region, below eye, tympanum and a stripe continuing down on side) is almost invariably the same. I have however found two specimens (7980 Chicago Natural History Museum, Suretka, C.R. and K.U.M.N.H. No. 30872, Moravia, C.R. that differ in this character. The black on the side of the head is broken into a series of discrete dark brown or black spots separated or bordered by clay white, that extend from the tip of the snout to behind tympanum. The Suretka specimen has the tarsal fold extending farther on tarsus than in the described specimen.

Remarks: Individuals were found in deep forest hopping about the forest floor in the daytime. There is no vocal sac in the male, and I am not aware of having heard them make any calls.

Specimens have been taken by me at Moravia (Caribbean drainage); Isla Bonita; Morehouse Finca, Turrialba; it is probably widely distributed in Costa Rica. I have not taken specimens above 5500 ft. elevation. It has been reported from Navarro and Guápiles.

Eleutherodactylus podiciferus (Cope)*

Figures 25, 26, 27, 28

- Lithodytes podiciferus* Cope, Journ. Acad. Nat. Sci. Philadelphia, new ser., vol. 8, 1875, pp. 107-108, pl. 23, fig. 9 (type locality, 5000-7000 feet elevation on Pico Blanco, eastern Costa Rica); U. S. Nat. Mus. Bull. 32, 1887, p. 16.
- Hylodes podiciferus* Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 56; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 203.
- Lithodytes muricinus* Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 108-109, pl. 23, fig. 13 (type locality, Pico Blanco, eastern Costa Rica).
- Hylodes muricinus* Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 56; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 203.
- Lithodytes muricinus muricinus* Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 16.
- Lithodytes muricinus habenatus* Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 16.
- Lithodytes rhodopis* (part.) Cope, Proc. Amer. Philos. Soc., vol. 31, 1893 (Dec. 23), pp. 337-338.
- Hylodes rhodopis* (part.) Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug., 1900, pp. 232-233, pl. 67, fig. c, c'.
- ?*Eleutherodactylus rhodopis* Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Aug. 17, 1921, p. 161 (Camino del Río, Costa Rica).
- ?*Eleutherodactylus blairi* Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, pp. 29-30, pl. 3 (in color) (type locality Gutiérrez, Boca del Toro province, Panamá, near the Costa Rican frontier).
- Lithodytes habenatus* Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 109 (type locality, Pico Blanco).
- Hylodes habenatus* Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 56; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 203 ("probably not different from *muricinus*").

Cope's early report (1875) on the William Gabb Collection, made chiefly at varying elevations on Pico Blanco, a high mountain in southern Costa Rica, named certain forms that would appear to belong to the species here considered. Unfortunately the preserved material was not in the best physical state when studied which may account for Cope's failure to comment on many of the salient features; and he may not have used adequate magnification to discern the less salient characters. His treatment consisted in naming and briefly characterizing three presumed species: *Lithodytes podiciferus*, with varieties A, B, C, and D; *Lithodytes muricinus*, and *Lithodytes habenatus*.

* *Eleutherodactylus podiciferus* (Cope), Amer. Philos. Soc., vol. 18, Aug. 11, 1879. The species reported from Tehuantepec. This reference was not considered by Smith and Taylor, "An annotated checklist and key to the Amphibia of Mexico," although mentioned by Taylor and Smith in an earlier work.

I have chosen the name *podiciferus* to stand for what I presume to be the single species involved because it has page preference and is somewhat better characterized than the two other names. Cope (1887) placed *habenatus* as a subspecies of *muricinus*. Later (1893) Cope placed *podiciferus*, *habenatus*, and *muricinus* in the synonymy of *Lithodytes rhodopsis* Cope.

Subsequent writers treating forms of the species here considered under the name *Eleutherodactylus podiciferus* have presumed it to be identical with the Mexican species known as *Eleutherodactylus rhodopsis* (Cope), whose type locality is "vicinity of Orizaba," Veracruz, and whose range reputedly extends southward through Central America to Brasil. I have seen no specimens of *E. rhodopsis* from southern Central America, and I regard it as probable that specimens of the group treated here may have served as a basis for certain reports of the occurrence of *E. rhodopsis* in Costa Rica

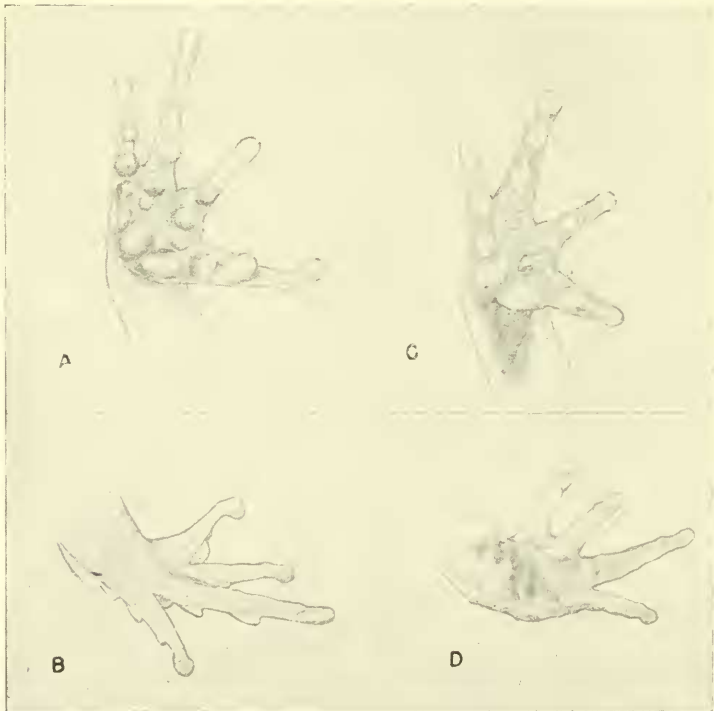


FIG. 25. *Eleutherodactylus rhodopsis* Cope. Mexico. Fig. A, hand, ventral view; fig. B, hand, dorsal view. (Note length of digits and the projection of the subarticular tubercles.)

Eleutherodactylus podiciferus Cope. Fig. C, hand, ventral view; fig. D, hand, dorsal view.

and south and southeast of this country. Certainly none of the large series of specimens at hand (more than 100) of this variable group is *E. rhodopis*. Cope who finally accepted this synonymy had very poor and very meagre materials on which to base his judgment and perhaps was influenced in his action by other herpetologists who likewise, with very inadequate materials, regarded the Mexican and Costa Rican forms as synonyms. (See fig. 25.)

But having made certain that *E. rhodopis* is not involved here, one finds in Costa Rica within the limits of what is probably a single species such an extraordinary lot of inexplicable variation in structure and color pattern, that a number of species would appear to be involved. These may be segregated into groups, having the same general structural characters and the same general color patterns. That these groups do not represent distinct species or that more than a single species is involved, has not been proved. However, one reasons, that to have six or eight species of a single section of a genus occurring in the same locality without any significant change in body form or size, is rather unlikely. Most of the easily observable differences in these lots are those involving the dorsal folding and tuberculation of the skin; the relation of these folds to the color pattern variants; the tuberculation of the sole, palm, and underside of the digits; and the presence or absence of granulation of the venter. Thus the venter may be distinctly covered with granulations, may be partly covered or may be smooth; supernumerary tubercles sometimes approaching the size of the subarticular tubercles may be present or absent or variable in number. The development of symmetrical patterns of folds does not seem to follow a general over-all plan, as occurs to considerable extent in other species of *Eleutherodactylus*. In these segregated groups a certain general type of color pattern is usually associated with a particular arrangement of the dorsal folds and tubercles.

I have drawn up a somewhat detailed description of one form, K.U.M.N.H. No. 28283 representing one of the most distinctive variant groups; this is followed by a series of shorter descriptions of other variant forms dealing chiefly with color pattern and the disposition of dorsal folds, the tuberculation and granulation of the ventral surfaces; the shape of fingers and toes remain rather constant throughout. Only when adequate breeding experiments have been made will it be possible to determine whether or not the arrangement here given is tenable wholly or in part; and in its present form should be regarded as tentative.

Just how many major varieties of *podiciferus* occur in Costa Rica cannot be stated; but I strongly suspect that each separate zoogeographic province may have developed variations of its own, while certain provinces may have several forms in the same place. In the material available to Cope from Pico Blanco is one variety (var. C) that is not represented in my collections. There are certain ones in the collections at hand that may not be present on Pico Blanco. Because of the diversity of varieties it becomes a matter of difficulty to define the species as a whole. However the following will serve in some measure.

Diagnosis: Moderately small frogs their adult size rarely exceeding 34 mm. in length for females and probably 26 mm. represents a maximum for the males. Body above with long or short dermal tubercles and folds; a more or less distinct ridge on outer edge of eyelid continuous with the supratympanic fold, which continues in a straight line not bending down behind tympanum; inner tarsal folds represented by an indistinct short ridge or tubercle, the outer by a short ridge or tubercles; venter perfectly smooth or strongly granular with or without well-developed supernumerary tubercles on under surface of pes and manus; tympanum variable in the sexes but always distinctly below supratympanic fold (i. e. not partly covered by it); first and second fingers equal, but no grooves around their tips; choanae lateral; vomerine teeth in two transverse fasciculi, situated behind choanae, separated mesially by less than one third their length; vocal slits present situated near back level of tongue and near jaw angle; the tooth series consisting of 8 to 12 teeth in adults; heel to tip of snout or slightly beyond; subarticular tubercles usually low, large, rarely moundlike or biscuit-shaped (never strongly conical and forward pointing as in *rhodopis*); no trace or only a very indistinct trace of digital webs; digital discs present, those on fingers not wider than part of digit immediately behind them, those on toes variable, all at least slightly wider than the digit; inguinal gland minute or wanting; ventral disc if evident terminates anterior to thigh.

Diagnosis of variety: A small species (30 mm. ♀, 21 ♂). Tympanum large, not touching and not overhung by supratympanic fold, approximately three fourths of the length of eye; choanae small lateral; vomerine teeth in two large, slightly converging series behind choanae but between their inner levels; vocal sac and slits in males; tongue one-third free; a pair of dorsal folds, the area between and bordering them usually lavender to purple; heel to front of eye.

Description of species: (K.U.M.N.H. No. 28283.) Head rather short; the length of head (12 mm.) equal to width of head at the tympanum (12 mm.); canthi sharply defined, curving from eye to nostril; loreal region slightly concave, sloping obliquely to lip; areas about nostrils slightly swollen laterally, and a distinct depression between them on surface of snout; tip of snout rounding in profile, very slightly extended beyond lip (1 mm.); nostril closer to median lip-notch than to eye; tympanum of female, oval, the edges moderately defined, the height, 2.4 mm., the length, 1.8 mm.; separated from eye by a distance of 1.8 mm.; length of eye (3.1 mm.) minutely



FIG. 26. *Eleutherodactylus podiciferus* (Cope). K.U. M.N.H. No. 28283, Isla Bonita, Volcán Poás, Costa Rica. Actual snout-to-vent length 30 mm. (supratympanic folds are light colored but actually are more distinct than shown).

greater than distance to nostril (3 mm.), shorter than snout length (3.7 mm.); width of an eyelid (2.6 mm.) less than interorbital interval (3.2 mm.); distance between nostrils (3.7 mm.) equal to snout length.

Choanae small, widely separated, lateral, diameter of one in distance between them more than eight times; vomerine teeth in two elongate fasciculi, converging slightly, separated mesially by third length of a fasciculus, much behind but lying within inner level of choanae; tongue longer than wide, broadly rounding behind without emargination, much narrowed in front, free posteriorly for nearly a third of its length; (vocal sac and vocal slits present in

males very far back, behind tongue); ostia pharyngea much larger than choanae.

Arm with wrist reaching tip of snout; fingers short the first slightly shorter than second when laid side by side; the terminal discs not or but slightly wider than digit in females (distinctly wider in males), and the edges of the discs lack transverse grooves unless disc is slightly shrivelled or dried; no (or scarcely) trace of web on hand or foot; subarticular tubercles large, rather flat; an oval inner metacarpal tubercle one half length of first toe, and a larger rather elevated median palmar tubercle; faint indication of supernumerary tubercles; a row of three tubercles on under surface of arm, and a slight irregular ridge on the dorsal surface of arm.

Heel reaching beyond tip of snout; toe discs larger than finger discs, symmetrical, somewhat pointed oval in shape, all with a transverse groove, and without web; inner metatarsal tubercle oval, half length first toe; inner tarsal fold represented by a short ridge or tubercle some distance back of the inner metatarsal tubercle, while the outer tarsal tubercle is large, rounded, distinct; subarticular tubercles a little more elevated than those on hand; none, or but slight trace of supernumerary tubercles; an outer tarsal ridge or fold broken somewhat into a row of tubercles.

A pair of strong, slightly sinuous dorsal folds begin near eyelid and curve gently inward on the shoulders then turn again outward to reach their greatest separation on the sacrum, then suddenly curving in again only to turn out abruptly and terminate on sides of rump; a ridge across edge of eyelid continues straight with the supratympanic fold which runs diagonally to a point above arm insertion; a pair of short ridges or elongated tubercles somewhat anterior to outer edges of sacrum; sides strongly granular or tubercular, the granules sometimes tending to form longitudinal lines; dorsum with minute granulation or tuberculation; dorsal surface of limbs strongly granular and at points where the dark bands cross leg there is often a diagonal ridge or tubercles; chin and breast without granules; edges of the abdominal area with granules sometimes covering nearly half the area; abdominal disc not or only very faintly indicated; median and posterior parts of thigh granular.

Color: In life, dorsal coloration consists of a broad brownish-purple stripe covering top of head and occiput, narrowing on shoulders and continuing back to thigh level or end of rump, the color extending a little beyond lateral limits of the dorsal sinuous folds; this bordered laterally by a light tan stripe limited anteriorly

by the skin folds (supratympanic and dorsal); it continues back merging with the light tan coloration of the sides and rump (this light region may contain some purplish tubercles and brownish flecks); side of head purplish, becoming somewhat more intense from tympanum to tip of snout; from tympanum to back of arm insertion, below the supratemporal fold, somewhat brownish or purplish brown; arms and legs barred with purplish bands of greater or lesser intensity; venter and concealed surfaces with pigment, nearly uniformly distributed except on under side of tibia and a region on front inner face of thigh; a purplish triangular area on posterior face of thigh including anus; under side of tarsus and foot purplish.

Measurements in mm. of Eleutherodactylus podiciferus (Cope)

Museum numbers	{ K.U.M.N.H 28283 ♀	K.U.M.N.H. 28284 ♂
Snout to vent	30	21
Length of head	12	8.5
Width of head	12	9
Length of snout	3.7	3
Length of eye	3.1	2.8
Tympanum height	2.4	2.3
Tympanum length	1.8	2
Arm	18	11
Hand	8	5
Leg	41	24
Tibia	18.4	12.2
Tarsus and foot	24	15.5

Variation: The specimens examined are K.U.M.N.H. Nos. 28283, 28284, 28285; R.C.T. 1587, 1662, 1743, 2353, 2651, from Isla Bonita.

The chief differences observable are, I believe, sex differences, the males having somewhat rougher tuberculation, much larger tympanum, and in larger males relatively larger digital discs, with the purple on side of head less intense. The supernumerary tubercles may be dimly present.

The color pattern is maintained, save that the young specimens have the contrast between the light and dark parts of the pattern much greater, and the banding of limbs is less intense. A faint ridge behind the tympanum may be indicated and there are two tubercles behind lower level of tympanum. In males the lower edge of the tympanum is nearly on a level with commissure of the mouth. The vocal slits are short and far back, usually beginning near back level of tongue. In younger specimens the rows of vomerine teeth are shorter with fewer teeth (10-12 teeth in adults).

This form resembles somewhat *Eleutherodactylus venustus* of Mexico in general habitus and in markings but differs in the character of the hand and foot, the first finger being distinctly shorter than second instead of considerably longer; the tympanum usually a fourth of its diameter below supratympanic fold instead of touching the same; the vocal slits are short (not partly covered by a skin fold); the terminal discs are distinctly larger and the supernumerary and subarticular tubercles are smaller and less elevated (the supernumerary tubercles are barely indicated in the female of the Costa Rican form); the tooth rows are transverse elongate instead of narrow and diagonal as in *E. venustus*.

“*podiciferus*” form

Figure 27

Probably the form that approaches most closely to the figured specimen of *Lithodytes podiciferus* (U.S.N.M. No. 30675) is K.U.M.N.H. No. 28259 from Isla Bonita. This specimen is generally clay or fawn colored with a pair of narrow, nearly parallel ridges beginning on the snout and continuing on to rump. There is a weak fold beginning some distance behind the eye running back dorsolaterally and somewhat irregularly to a point beyond the middle of body. There is a fold or ridge across the edge of the



FIG. 27. *Eleutherodactylus podiciferus* (Cope). K.U.M.N.H. No. 28259, Isla Bonita (American Cinchona Plantation) Volcán Poás, Costa Rica. Actual snout-vent length, 34 mm. This is the variety similar to the typical form named by Cope, *podiciferus*.

eyelid that continues on above tympanum not turning down behind tympanum but continuing back in a straight line; the legs are barred with brown and the surface bears a few larger tubercles on the bands; the dark coloration on the side of the head and snout is purplish but behind the tympanum it tends to run down to venter. On the side its upper edge forms a diagonal line. There is very little granulation evident above, but under a lens a very fine granulation is discernible. The sides have small granular tubercles and the outer part of the abdominal region is distinctly granular, while the remainder of abdomen as well as breast, chin and throat are smooth. There is a hair-fine median light line on dorsum and a white line on the back of the thighs that is usually distinct. This specimen has the vomerine teeth in two very elongate transverse series, closely approximated mesially and extending out beyond the inner level of the choanae. The head seems to be narrower in this form in comparison with the length of the body. There is less pigment on the under surface of the feet than is usual.

The following specimens of this color form are available: K.U. M.N.H. Nos. 28259-28264; R.C.T. 1596, 1647, 1656, all from Isla Bonita, Volcán Poás.

“*muricinus*” form

Figure 28

This form which is similar to Cope's *Hylodes muricinus* assumes some variety in the details of the color patterns but in all of the specimens there is a dorsal area nearly uniformly colored in lavender, pinkish, purplish or clay from snout to end of rump. This color is bordered laterally by the dark purplish or black color of the side of the snout and head. Behind the tympanum a diagonal lighter stripe from groin pushes up and joins the dorsal color. Beginning behind the shoulder is a strong fold on each side, separated anteriorly by a distance of 7 mm. At first the folds are slightly sinuous. They converge gradually onto the rump where they are separated by a least distance of 4 mm. They again turn outward and become thickened just as they terminate. About midway on the side of the fold is a small branch running down and back for a short distance. The canthus is distinct and continuous with a ridge that passes over the edge of the eyelid and continues back from eye above tympanum, running diagonally. The tympanum which does not reach upper level of this fold, has a diameter (2.65 mm.) less than the length of the eye opening (3 mm.); the width of the eyelid (2.5 mm.) is much less than interorbital width (3.9 mm.); there are continuous ridges across the tibia, deep black



FIG. 28. *Eleutherodactylus podiciferus* (Cope). K.U.M.N.H. No. 31071, National Park, on Pan-American Highway above Empalme. Actual snout-vent length, 29.5 mm. This form is similar to that variety named by Cope, *muricinus*.

in color, and when leg is folded they are more or less continuous with smaller ridges on the thigh. The venter is more or less granular. This pattern is figured (see fig. 27).

This specimen figured has the following dimensions:

Measurements in mm.: Snout to vent, 29.5; width of head, 12; length of head to behind jaw angle, 12.1; arm, 17; hand, 7; leg, 55; tibia, 18; foot and tarsus, 14. The figure presented No. 31071 gives a reasonably good illustration of the form. Seven specimens referred to this form are K.U.M.N.H. Nos. 31043-31046 from the National Park on the Pan-American Highway on the way to Cerro de la Muerte; and R.C.T. Nos. 1778, 1792 from Isla Bonita, Volcán Poás.

"podiciferus var, B"

The specimens in this lot have the dorsal folds arising near the eyelid running diagonally back and mesially until they are narrowly separated (2 mm.); from here the folds diverge and continue back, curving around the sacral dilation and again converging somewhat, terminating on the rump in two slightly thickened ridges, not approaching within 6 mm. of each other in large adults. There is

only a trace of an outer fold in some, in others a small lateral fold is evident. The supratympanic fold is strongly defined in all.

Three of the specimens are dark, blackish; two, generally grayish or grayish brown above, all have an irregular whitish bar from the corner of the eye diagonally across the tympanum and on to the base of the arm. The bright rufous spot mentioned by Cope is not present, the side of the snout being blackish (red may have been present in life). One specimen, the largest female, has a hair-fine median line. The gray specimens are lighter on the ventral surfaces, there being some pink color on the thighs; the darker specimens have more pigment on the ventral surfaces; the large triangular area on back of thighs has no white lines. The venter is without granulation; subarticular tubercles are low, rather large, the supernumerary tubercles not or slightly indicated. The two largest specimens measure 32 mm. from snout to vent.

Specimens having these characters are K.U.M.N.H. Nos. 31059-31064. All are from the National Park.

"habenatus var."

Several specimens in the collection agree with the form named by Cope, *Lithodytes habenatus* from Pico Blanco.

There are eight specimens with a broad light stripe from eye continued back to groin and on to the base of the thigh. This may be flesh white or pinkish in color. The dorsum is indefinitely variegated in brown, gray or blackish, the hind limbs being lighter than the body and barred with darker color. The venter is flesh white, with a scattering of pigment (in one case very heavily pigmented). Folds on the back are the same as those in variety B, the lateral fold being distinct in part of the specimens and indistinct in others. One of the lot has a fine median light stripe and a white line crossing the thighs. The two largest specimens measure 33 and 35 mm., respectively. Specimens referred to the "habenatus" variety are K.U.M.N.H. Nos. 31047-31054. These are from the National Park area on the Pan American Highway, on the road to Cerro de la Muerte. A second lot consists of K.U.M.N.H. Nos. 31055-31058 and R.C.T. 1650, 1661, 1674 from Isla Bonita, Volcán Poás.

There are several minor color varieties in specimens having similar arrangements of the dorsal folds as in the *habenatus* variety. Nos. 3758, 5689, 5698, 5711 from the National Park have the ridges all dark colored on the dorsum, with a dark interorbital bar and a tiny cross bar behind the shoulders, connecting the two dorsal folds

at the point of narrowest separation. Two of the specimens are nearly pigmentless below; two have much pigment on venter.

A second variety from the National Park differs in having the two dorsal folds begin some distance back from the eye, converging for a distance then diverging, with the two short lateral folds connected with them anteriorly and curving out. There are three light spots, one mesial, two others lateral to it, more or less clearly defined on or somewhat behind the shoulders.

The following specimens are of this variety: K.U.M.N.H. Nos. 31065-31070, all from the National Park. Among the specimens from the National Park and surroundings are 53 that do not fall clearly into any particular color pattern heretofore listed. Their dorsal folds are placed in the general "hour-glass" arrangement.

From Isla Bonita there are some 91 specimens that are rather uniform in general characters. The dorsal folds enclose the hour-glass area on dorsum, there are two dark spots on the back where the lines are closest together and another pair on the rump. The side of the head is usually uniformly dark but occasional specimens have light areas separated by darker areas in the loreal region and below the eye. These specimens are small, all under 28 mm. in length. K.U.M.N.H. Nos. 28290-28335, 28411-28431, from Isla Bonita and a similar series present in the R.C.T. collection are of this variety.

Quite similar to these save in ventral granulation and tuberculation is a series from Isla Bonita 28398, 28402-28408, 28410, and a smaller series K.U.M.N.H. Nos. 28395-28397, 28409, from Boquete Camp on the west slope of Cerro de la Muerte.

In these the greater part of the abdomen is strongly granular; the subarticular tubercles are very large (but never pyramidal or conical) and supernumerary tubercles are well developed on the hands and feet. There is a series from those localities represented in the R.C.T. collection. The dorsal characteristics of these two latter groups are not uniform, however they do not seem to fall clearly into major varieties mentioned heretofore.

Eleutherodactylus melanostictus (Cope)

Lithodytes melanostictus Cope, Journ. Acad. Nat. Sci. Philadelphia, N.S., vol. 8, 1876 (1875), pp. 109-110, pl. 23, fig. 10 (type locality, Eastern Costa Rica, 7000 ft. elevation on Pico Blanco; W. W. Gabb, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Hylodes melanostictus Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1 and 2, 1881-1882, pp. 56-57; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the British Museum, 2nd ed., 1882, p. 210; Günther, Biologia

Centrali-Americana; Reptilia and Batrachia, 1900, p. 224, pl. 65, fig. A; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 428-429 (places *L. engy-tympaanum* in synonymy).

? *Eleutherodactylus p. engytympaanum* Dunn, (*part.*), Acad. Nat. Sci. Philadelphia, vol. 92, 1940 (Nov. 18), p. 108 (considers *fleischmanni*, *euryglossus*, *engytympaanum* and *pittieri* as conspecific with *Eleutherodactylus punctiolus*).

Diagnosis: Head rather short; body rather elongate; vomerine teeth in widely separate series; not extending beyond inner level of the choanae; ostia pharyngea and choanae of about same size; tongue sub-round, one third free; canthi rostrales straight, convergent; diameter of eye equals distance between eye and nostril; tympanum narrow vertical oval one fourth eye; finger discs larger than those on toes; skin smooth; first finger shorter than second.

Description of species: (From Cope *loc. cit.*). "A species of distinct type from the preceding [*habenatus*] in its short head and longer body. Size of *Rana temporaria*. The vomerine teeth are in two short transverse series entirely behind the inner nares, well separated from each other and not extended outwards beyond the line of the inner margin of the nares. Choanae and ostia pharyngea sub-equal; tongue sub-round, one-third free, and a little emarginate behind. Head flat, wide, muzzle projecting a little, canthus rostrales straight convergent. Nostrils more than twice as far from orbits as from end of muzzle; their distance apart 1.33 times in their distance from the orbit. Loreal region and lip oblique. Diameter of eye equal distance from its border to the nostril, its area four times that of the membranum tympani, which is a rather narrow vertical oval. Skin everywhere smooth. Limbs long, dilatations of fingers large, of toes moderate. The muzzle marks the middle of the cubitus and a little beyond the middle of the tibia. The order of lengths of the fingers is, 1-2-4-3; first and third toes equal. The sternum is a wide cartilaginous shield notched at the end. There is a well-developed zygomatic process of the squamosal bone, but no corresponding malar process.

Color: "Ground-color above, brownish-gray; below, dirty-white. The limbs are cross-banded rather distantly with blackish, the bars extending on the front and back faces of the femur as well as on the upper surfaces. A white median band from muzzle to vent, which is bounded on the sides at different points with blackish. A pink band extends from above the tympanum to the end of the ilium and is broadly bordered with black on the outer side, this color extending on the sides of the animal as oblique black spots. The tympanum is black and sends a black bar to the rictus oris; two

black bars pass directly from the orbit to the lip, and another by the canthus rostralis and nares to the same.

One specimen from 7000 feet elevation on the Pico Blanco.

Measurements in mm.: "Length of head and body, 50; length of head to angle of jaw (axial), 15; width of head at angle of jaws, 22; length to orbit (oblique), 7; length to axilla, 19; width of sacrum, 9; length of fore limb, 37; length of fore foot, 19; length of hind limb, 96; length of hind foot, 45."

Remarks: I have not identified this species in the collections. It may be confined to Pico Blanco and the high peaks of the Talamanca Range.

Elcutherodactylus rugosus (Peters)

Figure 29

Hylodes rugosus Peters, Monatsb. Akad. Wiss. Berlin, 1873, pp. 610-611 (type locality, Chiriqui, Panamá, length 21 mm.); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed. 1882, p. 205; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug. 1900, p. 233 (Nicaragua); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 432 (Nicaragua, Panamá); Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, pp. 329-331 (places *Lithodytes megagephalus* Cope in synonymy).

Lithodytes megagephalus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 110-111, pl. 23, fig. 11, 11a (type locality, Pico Blanco, Costa Rica, 6000 ft. elevation; W. W. Gabb, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Hylodes megagephalus Brocchi, Mission Scientifique au Mexique. . . . Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 57; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, pp. 210-211; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1901, p. 239 (Las Delicias and Santa Clara, 500 m. elevation, Costa Rica); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 436-437, fig. 319.

? *Lithodytes pelviculus* Cope, Proc. Amer. Philos. Soc., 1877, vol. 17, p. 89 (type locality, "west coast of Central America"); and U. S. Nat. Mus. Bull. 32, 1887, p. 16.

? *Lithodytes gulosus* Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 112 (type locality, Pico Blanco, Costa Rica; 6000 ft. elevation, W. W. Gabb, coll.).

Hylodes gulosus Boulenger (*loc. cit.*), p. 211; Günther (*loc. cit.*), p. 240; Nieden (*loc. cit.*), p. 437.

Elcutherodactylus rugosus Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, 1921, p. 161 (Monteverde).

Diagnosis: Body curiously toadlike; head very broad, the back rugose, bearing bony ridges, which pass back from orbits and form a pair of curving lines on anterior part of back; these are not continuous with plicae (or lines of tubercles) that originate in groin and diverge along sides of body to sacrum; venter cream, heavily reticulated with black or brown; digits small, the discs scarcely widened; length 103 mm.

Description of species: (K.U.M.N.H. No. 28176 ♂, Morehouse Finca, 4½ mi. S Turrialba.) Body squat, toadlike, head much wider than body with a pair of parallel bony crests beginning between orbits at their anterior level, in contact with inner edge of eyelid, extending some distance on occiput, posterior ends tending to turn mesially; area between crests depressed; snout flat; canthus rostralis distinct, angular or nearly so, terminating above nostrils; area about



FIG. 29. *Eleutherodactylus rugosus* (Peters). K.U.M.N.H. No. 21175; Isla Bonita, Volcán Poás, Costa Rica; snout-to-vent length, 29 mm.

nostrils slightly swollen with a slight depression between them and from their anterior level snout slopes abruptly down to lip; snout not projecting beyond line of mouth; loreal region concave, jaw-rim spread much beyond outline of snout; eye moderately prominent, its length (4.8 mm.) a little greater than its distance to nostril (4.1 mm.); length of snout 6 mm.; tympanum of male very large, sub-circular, its diameter (4.2 mm.) a little smaller than length of eye; length of head (16.8 mm.) practically equal to its width (17 mm.);

width of an eyelid (5.2 mm.) a little less than interorbital distance (measured from outer edges of crests).

Choanae moderate, the plane of openings somewhat vertical to that of palate and vomerine teeth; latter in two somewhat triangular, elevated fasciculi, each bearing six teeth in transverse rows, narrowly separated medially, lying between inner level of choanae and considerably behind them, the elevated areas failing to reach their posterior levels; openings of Eustachian tubes larger than choanae; tongue somewhat cordiform, save that posterior emargination is slight or absent, free for about one third of its length.

Arms short; fingers small, the first distinctly longer than second or fourth; discs on fingers small, that on second finger smaller than others; a distinct groove is present at edge of discs; subarticular tubercles well developed, supernumerary tubercles (five or six) on palm indistinct; a large, elongate, metacarpal tubercle at base of first finger; palmar very large, bifid; two tubercles on under surface of arm, partially connected with a low ridge or indistinct tubercles; dorsal surface of arm with numerous rough tubercles.

Legs rather long proportionally, the heel reaching to nostril; discs on toes a little larger than those on fingers, largest about one fourth diameter of tympanum; those of outer and inner toe, smallest; subarticular tubercles moderately strong, no supernumerary tubercles; inner metatarsal tubercle large, oval, elongate, more than half length of first toe; outer tubercle relatively large, low; along outer side of foot and tarsus a low short indistinct inner tarsal ridge or fold; outer tarsal fold represented by several tubercles continuing from outer edge of foot.

Skin of head minutely tubercular with some large tubercles intermixed; eyelid with numerous rather large tubercles; a large irregular wartlike elevation above tympanum from which arises a skinfold that passes back toward middle line, terminating in front of the sacrum; skinfolds, beaded with tubercles, arise far back on rump and run forward diverging and terminating on outer edge of sacrum; a small ridge runs toward groin from posterior end of fold; skin of back and sides with very numerous granular tubercles and larger conical tubercles; legs covered with tubercles, the largest forming rows that cross femur and tibia where darker color bars cross them; venter and chin smooth; much of under part of thighs and area under vent with large, flat, smooth granules.

Color in life: Olive to brown-olive above with a faintly lighter area in interorbital region followed by a very dim transverse bar;

two slightly lighter stripes bordering external edge of body skinfolds, folds themselves rather black-edged on outer side; some very small black spots and silver spots border lower edge of eye; a narrow black line follows the supratympanic fold to behind tympanum, widening to cover upper half of tympanum; a black rump-spot following skinfolds; sides yellowish clay with a scattering of dusky olive; venter cream, the chin and throat clouded with dusky; venter and front of thighs cream, reticulated with intense black; thigh and tibia dimly barred above; intense black on lower posterior part of femur, the upper border of which bears cream spots; ventral part of thighs black with a few of the granules cream; under side of hand orange, especially digit tips, with some dusky markings; under side of foot black, the tips of digits orange; under side of tibia black, with cream spots.

Measurements in mm.: Snout to vent, 33; length of head, 16.8; width of head, 17; length of eye, 4.8; diameter of tympanum, 4.2; length of snout, 6; arm, 23; hand, 10; leg, 57; tibia, 19; tarsus and foot, 26.

Remarks: The synonymy given suggests that some confusion exists with regard to this species. The characteristics suggest generic differences from *Eleutherodactylus* and of the forms described, *rugosus*, *megacephalus*, *gulosus* and *pelviculus* all or part may represent recognizable forms. Cope believed that two forms *gulosus* (103 mm. in length) and *megacephalus* (70 mm. in length) occurred together on Pico Blanco in Costa Rica. The forms *rugosus* from Panamá (21 mm. in length) and *pelviculus* (less than half the linear dimensions of *megacephalus*) from an unknown locality "said to have been found on the west coast of Central America," shows certain differences from the larger female specimens, but whether these are actual differences or changes due to age or sex cannot be determined at the moment.

I have examined the types of Cope's Costa Rican *megacephalus* and *gulosus*, and owing to the condition of the specimens and absence of young, I could not prove beyond question the synonymy of these forms. Noble (*loc. cit.*), who studied specimens from Nicaragua was convinced that this material and the Pico Blanco, Costa Rican specimens were the same species. Only further collections from Pico Blanco of the supposed forms can settle the matter beyond doubt.

The ovarian eggs are 4 mm. in diameter suggesting that this species like many other *Eleutherodactylus* have omitted the free swimming larval stage.

Specimens in the collections at hand were taken in the forest at the Morehouse Finca four to five miles south of Turrialba. Two specimens were taken at Isla Bonita on the eastern slope of Volcán Poás at an elevation of approximately 5500 ft. The specimens were found moving about during the day on the forest floor. Occasionally they were routed out from under debris or small stones.

Since the preceding notes were written, I have obtained from Prof. Marco Tullio Pacheco, (K.U.M.N.H. No. 30771) a large specimen from near Turrialba (between Turrialba and the Morehouse Finca) that has the following characteristics: snout to vent, 65 mm.; hind leg, 95 mm.; head width, 34 mm.; head length, 25.6 mm. Fingers and toes free; small digital discs; leg brought forward the heel reaches to near front end of eye, the heels do not touch when legs are folded; a strong compressed inner metatarsal tubercle. The cranial crests begin at anterior level of the eye and continue to back of occiput, reaching their highest elevation and closest approximation at this point; two narrow lines beginning behind the strong supratemporal ridges curve back and in from shoulder, then curve outward to ends of sacrum from which point they can be traced back dimly converging to near end of rump.

First finger longer than second; tympanum vertically oval (5.2 mm. x 3 mm.); eye length, 8 mm.; eye to tympanum, 3.8 mm.; eye to nostril, 7 mm.

The vomerine teeth are in two triangular fasciculi lying partly between, but extending behind posterior level of choanae, and each considerably larger than a choana. The teeth are in slightly diagonal rows, converging mesially; ostia pharyngea distinctly larger than choanae. Canthus distinct not concave; a ridge from eyelid edge continuous with supratympanic ridge, which terminates in a slight boss directed inward.

Above, purplish black, with one still darker spot or band crossing thigh. Chin, breast, and sides finely reticulated with purplish lavender; center of venter cream with heavy blackish reticulation; back of thighs dark with some lavender mottling; ventral part of thigh, except distally, deep purple; front of thighs, under side of tibia and inner dorsal surface of foot coarsely reticulated, spotted or barred with purplish on a lighter ground.

The type of Cope's *Lithodytes megacephalus* has the cranial crests beginning considerably in front of eye.

The skin in Cope's specimen is smooth but this has considerable granulation on back, less on sides, and a few small flat granules or tubercles on chin; thigh below granular.

Eleutherodactylus ranoides (Cope)

Figure 30

Lithodytes ranoides Cope, Proc. Amer. Philos. Soc., vol. 23, no. 122, Apr. 1886, p. 275 (type locality, Nicaragua, J. F. Bransford, Coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Liohyla ranoides Cope, Proc. Amer. Philos. Soc., vol. 31, Nov. 17, 1893, pp. 335-336 (Terraba and "Buenos Ayres," Costa Rica); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1900, p. 225.

Hylodes ranoides Nieden, Das Tierreich, Lief. 46, Anura I, p. 431.

[*Eleutherodactylus*] *ranoides* Dunn, Proc. Acad. Nat. Sci., Philadelphia, vol. 92, 1940, p. 109.

Eleutherodactylus ranoides Barbour, Occ. Papers Mus. Zool. Univ. Michigan, no. 129, Jan. 25, 1923, p. 10 (Panamá).

Diagnosis: This species is represented in both collections by numerous specimens. It is variable in pattern but it may be identified by the following characters: a medium-sized species (females, three largest, 47-50; males, three largest, 30-32); having the same general appearance of *Eleutherodactylus crassidigitus* but legs distinctly shorter, the toes about one-fourth (or less) webbed; discs of two inner toes smaller than those of two outer; first finger in males thickened but distinctly less so than in *crassidigitus*; first finger longer and larger than second; toe discs equal or nearly equal to outer finger discs; heel reaches to tip of snout, or slightly beyond; a broad W-shaped mark often present and often a broad median



FIG. 30. *Eleutherodactylus ranoides* (Cope). K.U.M.N.H. No. 28375, Turrialba, Costa Rica. Actual snout-to-vent length, 46 mm.

light tan stripe; front of thigh marbled; back of thigh black or dusky enclosing cream-yellow spots; two small occipital folds; greatest diameter of tympanum of female three fifths length of eye; in male five sixths of eye length; six tubercles cross the back (in a curved row), the median pair less distinct, vocal slits in male.

Description: (From K.U.M.N.H. No. 28375, Turrialba, Costa Rica.) Snout rather narrowly oval; the width of the head (16.5 mm.) slightly less than head length (17.2); canthus rostralis present, rather rounded; loreal region vertical in upper part then sloping obliquely to lip; area about nostrils not or but slightly swollen, a slight depression between them and in front of them on tip of snout; snout projecting beyond lip 2 mm.; eye length (5.1 mm.) equal to or minutely less than distance of eye from nostril; length of snout 8.6 mm.; tympanum vertically oval (often nearly round or in males longer than high), its greatest vertical diameter (3.65 mm.) about .7 of eye length; a diagonal supratympanic fold (slightly curved or not) terminates above arm; a large multiple tubercle between tympanum and arm insertion; width of an upper eyelid, when flattened (4 mm.), a little less than interorbital distance (4.3 mm.); distance between nostrils, 4.6 mm.

Choanae largely lateral, the distance between them 4.5 mm.; vomerine teeth in two large triangular elevated fascicles, the anterior apex reaching to near level of middle of choanae and extending outward to near inner level, the tooth row much posterior to choanae but not behind the transverse palatal ridges; tongue somewhat oval, wider posteriorly and slightly emarginate behind, free for little more than one fourth of its length; male with elongate vocal slits, the vocal sacs forming indistinct folds at the sides of the angle of jaw.

Arm short, the wrist reaching tip of snout; first finger a little longer than second, the discs of the first two fingers small, equal in width; discs on two outer fingers larger, somewhat truncate, 2 mm. wide; subarticular tubercles large, rounded, elevated; supernumerary tubercles indicated but indistinct; a strong metacarpal tubercle at base of first finger, its length equal to a little less than half length of digit beyond tubercle; palmar tubercle large, partly bifid; no row of tubercles under arm.

Leg brought forward, the heel reaching tip of snout (rarely very slightly beyond); remnant of web between inner fingers about one fourth length of digit, not reaching anterior level of the proximal subarticular tubercles; between third and fourth and fourth and fifth approximately a fifth (or slightly less) webbed; (these remnants scarcely visible unless digits are spread); discs increasing in size to fourth (1.8 mm.), the fifth smallest; subarticular tubercles

distinct; no supernumerary tubercles on sole; inner metatarsal tubercle elongate, oval, half length of inner toe; outer tubercle rather large, round low; a distinct elongate inner tarsal fold, no trace of an outer fold.

A pair of indistinct, discontinuous folds beginning back of orbit and continuing back to middle of scapular region; some low tubercles across back representing three pairs, one mesial, one dorso-lateral and one lateral (often marked by black spots); on sides there are traces of two tubercular folds or an indistinct linear series of tubercles; back with numerous smooth, small, low tubercles; sides with more or less distinct, irregular granulation encroaching slightly on the ventral disc; chin, breast, venter, front face of femur, groin, and outer posterior face of thigh shining smooth; granular on much of under surface of thigh as well as about anal region; dorsal surface of thigh slightly rough; that of tibia smooth.

Color: (In alcohol.) A butterfly-shaped mark in interorbital region, the design edged with black; in front of this, light brown, with an irregular transverse mark, and farther forward on tip another irregular spot; on occiput a rather broad W-shaped mark; behind this on back some indefinite marks present mesially; in scapular region a few small deep black spots; lip with four dusky marks separated by lighter color. Arms and legs banded indistinctly above; posterior face of femur blackish enclosing small cream spots or reticulations; venter flesh with some dusky pigment often forming small flecks on ventral surfaces; a more or less distinct longitudinal white stripe on chin; foot and tarsus purplish, the hand lighter.

Measurements in mm. of Eleutherodactylus ranoides

Locality	La Suiza	San Isidro		Turrialba	Turrialba
		El General			
Number (K.U.M.N.H.)	28375	28384		28382	28379
Sex	♀	♀		♂	♂
Snout to vent	46	47.5		30	32
Width of head	16.5	18		10	12
Length of head	17.2	18		12	14
Length of snout	8.6	9		5.6	5.5
Length of eye	5.1	5.8		3.7	4
Height of tympanum	3.65	3.4		2.8	2.9
Length of tympanum	3	3.2		3.2	3.4
Arm	29	28		17.3	17.3
Hand	13	14		8.8	8.8
Leg	79	79		49	54
Tibia	27	29		17	18.3
Foot and tarsus	38	38		22	24.5

Remarks: Variation in color and markings is great but in no case does it seem to be geographic and the same types of variants occur in various localities.

The more striking color varieties are: K.U.M.N.H. No. 28383 ♀ (gravid) "Nearly uniform yellow olive above; chin and breast white; black and cream yellow spots on back of thigh; groin and limbs greenish yellow." In preservative light gray-lavender with faint W-shaped mark; other marks faintly visible. Reticulation on back of limbs strongly marked. A male of normal coloration was taken at the same time at Turrialba.

K.U.M.N.H. Nos. 28384, 28386, San Isidro El General; Nos. 28380, 28389, Isla Bonita; R.C.T. No. 479, Turrialba, Nos. 611, 2062, Isla Bonita, No. 1524 Los Diamantes. This series of specimens has a broad regular light tan or fawn stripe from tip of snout to vent, widening somewhat between anterior part of orbits and on snout; this is bordered by a dim dusky stripe; this in turn is bordered laterally by a lighter stripe, with another indefinite dusky stripe dorsolaterally; side of snout lavender, spotting obsolete on tip; tubercles and skin folds sometimes black-edged; in No. 28384 particularly the skin bordering the fawn stripe is elevated into a flat ridge, and the other ridges and tubercles seem a little rougher. No. 479 has the back very rough and pustular with an indistinct fold along borders of the fawn stripe; sides very granular with intermixed pustules. The heels may be of a lighter fawn color.

The constant characters of marking are: the light line on chin, the dark or black color of the posterior part of the thigh enclosing cream spots, or the region reticulated black and cream.

Specimens were found under rocks along rivulets. When disturbed they would take refuge under the water crouching on the bottom. Males were more often found hopping about in daylight in the forest.

Cope recognized specimens from southwestern Costa Rica as belonging to *ranoides*. These originally were described from presumably young specimens, none of which measured more than 26 mm. in length. Cope later reported specimens from Bueno Aires and Terraba, Costa Rica, and lists four color varieties all of which are duplicated in the lots at hand.

This species suggests *Eleutherodactylus nubilus* Günther in many of its characteristics, especially in the general character of the dorsal and ventral markings on some specimens. The chief reasons for not considering the species identical with *nubilus* is that Günther specifically places the species in the genus *Hylodes*, and those forms

having webbed feet are placed in *Liohyla*. Other characters by which the species presumably differ is that *nubilus* has no outer metatarsal tubercle, the tympanum is smaller, the markings on front side of arm, and front and underside of tarsus differ, and the W-shaped mark on occiput is absent. All these point to a different form.

(In the figure given here the toes are not spread to show the web remnants.)

I have also considered the possibility that *E. ranoides* is a synonym of *Hylodes fitzingeri*, a species so poorly characterized as to make it impossible to determine whether such is the case without direct comparison with the type. The specimens however are, I believe unquestionably, the form referred to by Cope in his (Cope, 1893) paper—specimens from Terraba and Buenos Aires. I find that certain specimens of this form are labeled "*fitzingeri*" in the Harvard Collection.

Eleutherodactylus fitzingeri (O. Schmidt)

Hylodes fitzingeri O. Schmidt, Denksch. k. Akad. Wiss. Wien, Math.-naturw. Cl., vol. 14, 1857, p. 248, pl. 1, fig. 10, (foot only) (type locality, Cordillera of New Granada, 4000 ft.).

Eleutherodactylus fitzingeri Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, p. 386; *ibid.*, Oct. 10, 1931, pp. 410-411 (Barro Colorado I.); *ibid.*, vol. 8, June 7, 1933, p. 64; K. Schmidt, Smithsonian Misc. Coll.; vol. 89, 1933, p. 5 (Panamá).

It would appear that this species was not considered by Cope, Boulenger, Günther or Nieden, although the latter lists it with a question mark, without giving a description. Dunn believes that he has recognized the species as a common frog of Panamá and Costa Rica.

Diagnosis: A considerable remnant of a web on foot, extending distal to base of the metatarsals; back generally smooth; sides granulated; venter smooth; snout to vent length, 30 mm.

Description of the species: (Free translation of type description.) This new species of *Hylodes* which we take the liberty of dedicating to the author of the genus has a very slim body and belongs in the group in which the vomerine teeth do not stand in a zigzag line. In this they are closest to *Hylodes martinicensis* Tschudi; the latter however differs from this, especially by its stout body and from the habitus of most "Hylaformia." We need not go into a very careful description of details but we only emphasize the characteristic criteria.

The toes are correctly regarded as "split" but to avoid any misunderstanding we must mention that on the hind leg between the

third and fourth, and the fourth and the fifth toes there is, unimportant though it may be, the rudiment of a web, since the web reaches and is fastened beyond the ends of the metacarpal bones on the basal phalanges. It seems furthermore that in none of the other species is the *os cuneiform primus* so well developed as in this case. The dorsum is smooth, however, there are a few small elevations. The venter is also smooth; but on flanks it is granulated; on the thighs only the regions below and lateral to vent are granulated.

Color: The basic color of the dorsum is a grayish brown on which there are black flecks and streaks, the latter chiefly on the limbs. A yellowish streak runs around the curve of the tip of the snout and also goes onto the lower jaw, which on its front side is not rounded off but is truncate. The venter is yellowish but there are smaller dark flecks and the legs are of a uniform dark color from the heel onward.

Measurements in mm.: Body, 30; arm, 18; leg, 54.

The type locality is Cordilleras of New Granada, close to 4000 ft. elevation.

I have considered the possibility that this poorly defined species is the same as the one described herein as *Eleutherodactylus ranoides* Cope.

The form *fitzingeri* has very few characters recorded. Those listed for the foot might apply to one of several species; the body is very slim. The "*os cuneiform primus*" is especially well developed; skin is smooth, with a few small elevations on dorsum; a yellowish streak runs around the curve of the tip of the snout onto jaw; venter yellowish; above grayish brown on which there are black flecks and streaks. The figure shows the foot possibly one-fifth to one-fourth webbed. I doubt that these characters can prove the synonymy of *fitzingeri* and *ranoides*.

Eleutherodactylus crassidigitus sp. nov.

Figure 31

Type: K.U.M.N.H. No. 28369. Collected, Isla Bonita, eastern slope Volcán Poás between July 22-Aug. 3, 1947 by Richard C. Taylor and Edward H. Taylor.

Paratypes: K.U.M.N.H. Nos. 28360, 28361, 28440, Turrialba and surroundings; 28362-28374, Isla Bonita; R.C.T. Nos. 788a-c, 814, 1675, 2412, 2415, 2784, 2787-2789, 2792, 2796, 2800, 2802, 2803, Isla Bonita; 981-981a, Boquete Camp, west slope of Cerro de la Muerte, elev. 2000 m.

Diagnosis: A medium-sized species (females 44 mm.; males 30.5 mm.) characterized by toes one third to one half or more webbed; finger discs rather small, those on outer fingers much the larger; first finger shorter than second (in male very greatly thickened at base, its diameter more than half length of digit); tympanum of female about one half of eye length, of males equal to or at least about five sixths of eye length; heel reaches much beyond tip of snout; males with large vocal sac and slits; usually two pairs of dark tubercles on back between arms; skin nearly smooth above, with a supratympanic fold present.



FIG. 31. *Eleutherodactylus crassidigitus* sp. nov. Type. K.U.M.N.H. No. 28369. Isla Bonita, Volcán Poás, Costa Rica. Actual snout-to-vent length, 44 mm.

Description of the type: Head oval, not or scarcely as wide as body (exceptionally, wider in certain males and young females) its length (18 mm.) equals its width (18 mm.); snout rather narrow the canthus rostralis sharply distinct; areas about nostrils slightly swollen, the area between forming a flat depression; in lateral profile snout rounded, extending in front of edge of lip nearly two millimeters; upper part of lores nearly vertical, lower sloping

obliquely to lip, the region concave, roughened, with low indefinite pustules; length of eye (5.6 mm.) equal to distance between eye and nostril (5.6 mm.); length of snout, 8.5 mm.; distance between nostrils (4.3 mm.) equal to interorbital width (4.35 mm.); width of eyelid (measured flat) a little greater than interorbital width; tympanum distinct, slightly higher than long (3.4 x 3.1 mm.), its greatest diameter equal approximately to .6 length of eye (in males the proportion is .8 or more); a strong supratympanic fold curving down to near arm insertion, obscuring upper edge of tympanum; two tubercles on eyelid; two conical tubercles between tympanum and arm insertion; in interorbital region an elongate depressed area indicated, extending on to occiput; choanae large, lateral, the interior border somewhat elevated, distance between them 4.8 mm.; vomerine teeth in two almost contiguous, somewhat triangular fasciculi, the anterior points reaching to level of middle of choanae, their posterior level much behind choanae but not quite reaching level of transverse palatal ridges; combined length of vomerine series 4 mm.; tongue large, somewhat oval, a little wider behind (usually) and not or but slightly emarginate behind. (Males with elongate vocal slits, but little external evidence of a vocal sac in male paratypes.)

Arms rather short, wrist reaches tip of snout; heel reaches 10 millimeters beyond tip of snout; fingers with well-developed truncate discs, those of the two inner fingers distinctly smaller than the two outer; first finger equal or minutely longer than second; no finger webs but slight lateral ridges on sides of fingers; subarticular tubercles distinct, rounded, elevated; supernumerary tubercles only moderately distinct; a strong elongate metacarpal tubercle at base of first finger; palmar tubercle large, partly bifid, the outer part the smaller; no distinct row of tubercles under arm.

Legs long, a distinct, elongate, sharp-edged tarsal fold; none or but slightest trace of an outer fold or row of tubercles; toes with well-developed discs, slightly truncate, those on three middle toes largest, nearly size of largest discs on fingers; disc on outer toe not smaller than that of first toe; first three toes half webbed (two-thirds webbed between the second and third toes); about one-third webbed between two outer toes; subarticular tubercles distinct, elevated; no tubercles on sole; inner metatarsal tubercle elongate nearly half length of first toe; outer tubercle small but distinct; heels overlap 8 mm. when legs are folded; a very small heel tubercle.

Skin minutely shagreened above, with some slight tubercles behind orbits and tympanum suggesting remnants of folds; a pair of tubercles a little behind occiput, usually dark, and behind these a

second dark pair more widely separated; a third pair still more widely separated about middle of back, usually not dark colored (black in specimens from Turrialba); one or more tubercles (black or not) behind tympanum; side of body more or less regularly granular or areolate, the granules occasionally encroaching on edges of the well-defined abdominal disc; chin, breast, venter, front face of thighs, small area in groin, outer posterior face of femur and under tibia shining smooth; ventral surface of femur and region about vent granular.

Color in life: Above generally lavender to reddish olive brown, below whitish flesh with some scattered pigment on chin; under surface of sole and part of palm purplish; an indefinite, darker, interorbital bar, behind which, color more intense to near back of occiput; darker dusky marks on arms and legs; between the primary bars very narrow intercalated lines; dorsum and sides slightly clouded; side of lip with at least three indefinite darker marks and a slightly darker area below canthus; a dusky line follows supratympanic fold; tympanum with a dark mark; larger tubercle on sides of shoulders blackish.

Measurements in mm. of Eleutherodactylus crassidigitus sp. nov.

Museum number	(K.U.M.N.H. 28369 ♀	K.U.M.N.H. 28362 ♀	K.U.M.N.H. 28371 ♂	K.U.M.N.H. 28368 ♂
Snout to vent	44	44	28.5	28
Width of head	18	17.3	11.5	11.5
Length of head	18	18	11.5	11.4
Length of snout	8.6	8.3	6	5.3
Eye length	5.6	5.8	3.5	3.7
Height of tympanum	3.4	3.5	2.8	2.7
Length of tympanum	3.1	3	2.9	2.8
Arm	25.5	25.2	16.5	16
Hand	13	14	8	7.8
Leg	86	85.4	55	54
Tibia	30	30	19.5	19
Foot and tarsus	39	40	24	24

Variation: The variation in this species is chiefly sexual. The snout-to-vent measurements of eight of the largest females is between 42-44 millimeters; of the eight largest males between 28-30.5 millimeters.

The general color is a light brown to brownish lavender or grayish olive, sometimes nearly unicolor above with or without very indefinite darker clouding. A darker interorbital bar may or may not be distinct, the area on the snout being lighter brown or sometimes having the anterior part lavender. There may or may not be a

W-shaped pattern on shoulder region faintly outlined, with the anterior part of black tubercles marking the lower angles of the "W." Sometimes the area behind the interorbital bar as far back as the "W," is slightly darker than the remainder of the back. The upper edge of the loreal region is usually darker than the remainder and lip spots below eye may be dimly present or almost entirely obsolete. A dark line following the supratympanic fold is present and occasionally widens at the tympanum leaving its upper part dark. Ventral surfaces are white, the chin alone having a very scant peppering of pigment (visible under lens).

R.C.T. No. 2787, has a whitish mark across the front of the orbits, and on each side of head behind the eyes there is a large symmetrical lighter area involving part of the orbits and narrowly separated mesially. This pattern is less distinct in R.C.T. Nos. 2792 and 2794.

R.C.T. No. 2799 is grayish above, the bars on the arms and legs being strongly marked. A white bar crosses the front of the orbits and there is some dark flecking on the sides. The black line along the supratympanic fold is much widened behind tympanum.

Remarks: All the specimens were found moving about on the forest floor, at night for the most part. R. C. Taylor collected a specimen with 26 eggs from under a rock at Boquete Camp on the western slope of Cerro de la Muerte, at an elevation of about 6000 ft.

Eleutherodactylus palmatus (Boulenger)

Figure 32

Leiyla guentherii Keferstein, Nachr. k. Ges. Wiss. Georg-Augusts Univ. Göttingen, 1868, p. 330; Arch. Naturg. Jahrg. 34, vol. 1, 1868, p. 296, plate 9, figs. 4, 5 (*nec Hylodes güntherii* Steindachner, 1864).

Lithodytes guentherii Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 16 (*part.*).

Hylodes palmatus Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum (Natural History), 2nd ed., 1882, pp. 201-202 (*part.*); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 433-434, fig. 317.

Liohyla guentheri Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Apr. 1900, pp. 220, 221, pl. 46, figs. A, A' ("Costa Rica," "Río Ceibo," "Buenos Aires").

Eleutherodactylus palmatus Barbour, Occ. Papers Mus. Zool. Univ. Michigan, No. 129, Jan. 25, 1923, p. 10.

The species *Hylodes güntherii*, described by Steindachner, I believe must leave *Leiyla guentherii* Keferstein preoccupied if one accepts the synonymy of the genera *Hylodes* and *Leiyla* as I have done in this paper. The next available name is that of Boulenger, *Hylodes palmatus*. It would appear that the name is a substitute name for *Leiyla guentherii* Keferstein to which he refers Cope's

Liyla rugulosa Cope and *Hylodes rugosus* Brocchi. One suspects that his description may be of *rugulosa*.

Günther acquired Costa Rican specimens which he believed were the same as Keferstein's form from Panamá, and retains Keferstein's name since he maintains the species in *Liohyla*, a genus different from *Hylodes*.

The single specimen of this species which I find in my collection was captured at Isla Bonita, in an arboreal bromelia, about 15 feet above the ground and I feel quite certain that it is the identical



FIG. 32. *Eleutherodactylus palmatus* (Boulenger). K.U.M.N.H. No. 28255; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 72 mm.

species figured by Günther (1900, pl. 46, figs. A, A'). Whether this is identical with Keferstein's specimen may be doubted. Should they prove to be different, the name *palmatus* would then not be applicable to this species and it would be without a name.

Diagnosis: Large species (79 mm. ♀); characterized by having toes one-fourth to one-third webbed; digits long somewhat flattened with truncate terminal discs; nearly uniform black or brownish above; below dirty whitish with a broken reticulum of dusky lines; lower lip blackish, spotted regularly with cream; a median cream line on throat bordered with black; posterior part of thighs black

with discrete white or cream spots; groin area marbled dusky and yellow-cream or white.

Description of species: (From K.U.M.N.H. No. 28255.) Head about as broad as long, the canthus distinct, rounded, but becoming angulate near the eye; snout generally oval, rather pointed; loreal region distinctly concave, sloping obliquely to upper edge of maxillary then rounding under to lip edge; nostril swollen slightly; eye large, its length slightly less than the distance between eye and nostril; nostril much nearer tip of snout than eye; tip of snout projecting 2.2 mm.; tympanum oval, diagonally placed, its greatest diagonal diameter (4.1 mm.) more than half length of eye (7.4 mm.); upper eyelid (6.6 mm.) little greater than interorbital width (6.5 mm.).

Choanae moderately large, distinctly larger than the openings of the Eustachian tubes; vomerine teeth in two large triangular elevated fasciculi, separated from each other by a distance equal to their distance from choanae; on each fasciculus teeth numerous (10-11) extending out considerably beyond the inner level of the choanae, the elevated area reaching farther forward than their posterior level; tongue cordiform, large, free for only about one fifth its length.

Arms long, the wrist extends beyond snout two thirds length of forearm; fingers rather long with well-developed discs, somewhat truncate anteriorly, those on outer fingers larger than tympanum; first finger of about same length as second; fourth finger much larger than second; a *trace of a web* between the *three inner fingers* with a ridge continuing along sides of digits to tips; subarticular tubercles low, distinct; only a suggestion of supernumerary tubercles; an elongate much elevated metacarpal tubercle at outer ventral edge of first finger, its length half as long as digit from tubercle to tip; a large palmar tubercle almost divided mesially; tips of discs tend to turn up.

Leg elongate, the heel reaching 10 mm. beyond tip of snout; heels overlap 8 mm. when limbs are folded at right angles to body; toes with truncate discs, the largest distinctly ($\frac{1}{4}$) smaller than two largest finger discs; disc on fifth toe smallest; fifth toe fails to reach as far forward as third; three inner toes, approximately one third webbed; less between third and fourth, and with only a vestige between fourth and fifth; a lateral fringe or ridge to discs on all digits; a large inner metatarsal tubercle, with an outer not (or only faintly) indicated; subarticular tubercles large, flattened; no supernumerary

tubercles on the sole; moderately distinct, narrow elongate tarsal fold two thirds of the length of the tarsus.

Skin on dorsal surface of body and limbs lacking all folds and warts save a small round tubercle near tympanum and a narrow curving supratympanic fold, very clearly defined, terminating above and behind jaw angle; under a lens the skin is seen to be finely and smoothly corrugated; a very fine irregular fold traceable from occiput along each side of body (appearing like a vein); some granules about jaw angle, on sides (anteriorly), on mesial part of under face of thighs, and below anal region on posterior face; remainder of under surfaces, chin, throat, venter, as well as limbs, very smooth, with none or only a faint suggestion of a discoidal ventral disc.

Color and markings: Dark olive brown on back without spots; a vaguely defined, median, hair-fine line of light brown; arm and legs uniformly olive brown above; side of head rather dark, with at least four very indistinct darker marks, becoming better defined on the edge of the lip where they are separated by discrete cream spots; two tiny white spots just below lower rim of eye; tympanum black followed by a discrete diagonal black spot; sides of body lighter olive-brown, with whitish flecks, or posteriorly, larger discrete yellow spots; front of thigh clouded lighter and darker with a few yellow spots near groin; back of thigh black with numerous small yellow-cream spots; under surface of tibia clouded with dirty white and yellowish spots; palm and sole with digits deep purplish; chin with a black rim showing well-defined cream spots paired with similar spots on upper jaw; chin dusky, clouded with a dark-bordered, median whitish stripe; venter whitish, reticulated with dusky brown; under side of thighs with finer reticulations.

Measurements in mm. of Eleutherodactylus palmatus

Snout to vent	72	Eyelid width	6.6
Width of head	26.3	Interorbital width	6.5
Length of head	26	Arm	51
Length of snout	11	Hand	26
Height of snout	8.1	Leg	135
Length of eye	7.4	Femur and tibia	80
Tympanum	4.1 x 3	Tibia	43
Eye to nostril	7.8	Foot and tarsus	63

Remarks: I cannot but have some doubt that the *Leiyla guentherii* described and figured by Keferstein * is the same as this species.

The figure shows a round tympanum, digital discs much smaller

* Arch. für Naturg. Jahrg. 34, vol. 1, 1868, pp. 296-297, pl. 9, figs. 4, 5. (type locality Costa Rica).

than the tympanum and numerous warts and tubercles are present. The first finger is longer than second; the tympanum does not have small white flecks on a black surface, and there is no trace of a finger web. The color and markings are different.

As I have stated, my specimen, in general appearance, resembles the specimen figured by Günther as *Liohyla güntnerii*,† especially in the coloration of the ventral surfaces.

There is no distinct lighter area on the snout, and the dorsum is somewhat darker. Günther seemingly was not wholly certain of the identity of his specimen and suggests its relationship with *Hylodes raniformis*.‡ The type description of *raniformis* deals with a related frog, 70 mm. long. However, it differs from the species at hand in that the vomerine teeth are in two short series; first finger distinctly longer than second; subarticular tubercles very strong; toes one-third webbed; an indistinct outer metatarsal tubercle; ill-defined darker spots above on body; a blackish streak below canthus; limbs dark spotted; hinder side of thighs whitish, reticulated with dark brown; lower parts white, throat sometimes speckled; male with a vocal sac. Boulenger states that it is distinguished from *palmatus* by a broader interorbital region, smooth skin, and larger size. The type locality is "Buenaventura and Cali," Colombia.

Eleutherodactylus pittieri (Günther)

Liohyla pittieri Günther, *Biologia Centrali-Americana; Reptilia and Batrachia*, June 1900, pp. 223-224, pl. 65, fig. B, B' (type locality, "Costa Rica"; and Boruca, Costa Rica. Here restricted to the latter locality. Pittier de Fallega coll.).

Hylodes pittieri Nieden, *Das Tierreich*, Lief. 46, Anura I, 1923, p. 435 (Costa Rica).

Eleutherodactylus pittieri Dunn, (*part.*) *Proc. Acad. Nat. Sci. Philadelphia*, vol. 92, 1940, pp. 108-109 (regarded as conspecific with *punctariolus*).

Diagnosis: This large arboreal frog (♀ 60 mm.; ♂ 51) may be identified by the following characteristics: male without vocal sac, or vocal slits; first finger longer than second; toes scarcely one fourth webbed; one metatarsal tubercle; length of body less than distance between heel and vent; tympanum nearly round; in male $\frac{3}{4}$, in female $\frac{1}{2}$ eye; thighs black behind with small punctate yellow spots; no red on ventral surface. Heel reaches to beyond snout-tip.

Description of species: (From Günther *loc. cit.*) "Closely allied and very similar to *L. fleischmanni*. Habit rather robust, the length of the body being a little less than the distance between vent and heel. Snout not projecting beyond the mouth, of moderate length,

† Günther, *Biologia Centrali-Americana; Reptilia and Batrachia*, 1900, pl. 66, figs. A, A'.
‡ Boulenger, *Ann. Mag. Nat. Hist.*, ser. 6, vol. 17, 1896, p. 19.

with obtuse canthus rostralis and sloping sides. Tympanum round, three-fourths the size of the eye in the male, and about one-half in the female. Vomerine teeth as in *L. fleischmanni*. Male with some short tubercular folds and small tubercles on the side of the back, female nearly smooth. Abdomen smooth, without folds. Disks on the fingers small, of the toes moderately developed. *First finger longer than the second*. Toes barely one-fourth webbed. One metatarsal tubercle; a tarsal fold. *The hinder side of the thighs black, with well-defined small round lemon-yellow spots*; throat brownish, minutely speckled with yellow; abdomen whitish. Male brownish, faintly marbled with darker colour, sides marbled with yellowish; a narrow yellow vertebral line and a light interorbital cross-band. Female nearly uniform brownish-black above; sides marbled with yellowish."

Measurements in mm. female and male respectively: "Length of the body, 60, 51; distance between vent and heel, 62, 52; length of hind limb (from vent), 104, 87."

Remarks: "I have long hesitated before I ventured to distinguish this frog under a distinct name; however, the receipt of a second specimen agreeing in every essential distinctive character with the first, removed every doubt about the species being distinct from *L. fleischmanni*. The male has the testicles well developed, yet lacks vocal sacs. These organs are present in much smaller specimens of *L. fleischmanni*." This species described and excellently figured by Günther *loc. cit.* was found to be common in the region about Moravia. The species is decidedly different from *Eleutherodactylus fleischmanni* that occurs in the same general region. *E. pittieri* males lack the vocal sac and slits, and also lack the nuptial asperities on the first finger, which is longer than the second.

In a series of some 20 specimens taken at Moravia the five largest females measure, 60, 62, 62.5, 69, 72 mm.; the five largest males, 38, 38, 39, 39, 45 mm. All were taken along small rivulets at night. During the day they were effectively concealed.

The skin is usually rough with tubercles, short ridges and a more or less general corrugation. Some specimens have the dorsum rather smooth. The digital discs are relatively small, those on hand smaller than those on toes. In the large female the area of the largest toe disc is about one third of the area of the tympanum. The snout projects very slightly beyond mouth. The abdomen is smooth with a ventral disc usually outlined in the adults. The first finger is longer than second. The male has no nuptial asperities on the dorsal and dorsolateral surface of the first finger. In these speci-

mens the outer metatarsal tubercle is present but it is very indistinct and might be overlooked (absent in the types). The toes are about one-fourth webbed. The vomerine teeth are far behind choanae in two triangular fasciculi, the teeth in transverse series are separated by one fifth the width of a fasciculus. The tongue is rather small, subcircular, one fifth or less free behind and very slightly nicked. A strong inner tarsal ridge is present two thirds of the length of tarsus, arising from the edge of the inner tubercle. The sole and palm lack supernumerary tubercles, the subarticular tubercles being somewhat elongate. The general color is black or blackish above with a darker interorbital bar and some indefinite dorsal marks can be discerned when the specimen is submerged.

The sides are variegated, black with some white areas in groin, or light with black areas. The back of the thighs have small yellow or silvery-white flecks. There are only very indistinct marks on the lips; the legs are barred with darker.

The type locality Boruca is "situated in a small bowl-shaped valley in the hills on the north side of the Rio Grande de Terraba; having an altitude of 1500 feet," on the Pacific side of Costa Rica rather close to the Panamá border.

The greater smoothness of the types and the absence of the outer metatarsal tubercle may be individual variation, for at best the outer tubercle is small, often nearly obsolete.

Eleutherodactylus fleischmanni (Boettger)

Hylodes fleischmanni Boettger, Katalog der Batrachier-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main, Aug. 1892, p. 27-28 (type locality, San José, Costa Rica; Carl Fleischmann, coll.); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1900, p. 222, pl. 64, fig. B; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 434-435.

Eleutherodactylus fleischmanni Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Dec. 21, 1921, p. 161 (Santa Cecilia, Guápiles, La Palma and Cariblanco) (spelled *fleishmanni*); Dunn, Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 108-109.

Diagnosis: Toes slightly webbed at base with small narrow lateral fringes; belly smooth; head broader than body; tympanum large round; interorbital region flat; leg brought forward the heel joint reaching beyond tip of snout; no lateral glandular fold; no well-defined ventral disc. Male with vocal sac.

Description of species: (Free translation of type description.) Tongue oval unemarginate; vomerine teeth in two strong fasciculi behind level of choanae; head rather broad, distinctly broader than body; snout somewhat pointed, convex or curved on under side of tip; longer than diameter of eye; canthus more distinctly curved

and angular anteriorly than posteriorly; nostril twice as far from eye as from tip of snout; interorbital space as broad as a single eyelid; tympanum round, almost as large as eye; ostia pharyngea almost as large as choanae; fingers of medium length, first somewhat longer than the second; toes rather long, clearly connected at base, and with narrow lateral skin fringes; discs on fingers and toes small; subarticular tubercles moderately developed; two metatarsal tubercles, the outer round but less distinct than inner; the hind leg brought forward, the last fourth of the tibia reaches beyond tip of snout; skin smooth on dorsum with narrow warty ridges or tubercles; irregular glandular folds on eyelids and sides of body; one or two whitish tubercles on posterior lower edge of tympanum especially distinct and significant; venter smooth.

Color: Ash gray dorsally with a black powdering of pigment and with now and then a black dot; sides of head and body light gray with black flecks and marbling; a fine white dorsal streak as well as a carmine red band between the eyes; and similar red flecks on center of back and thighs may or may not be present; the dark bands on limbs wanting, or very obscure, but back of thighs black with white flecks; underside dirty white; borders of lower jaw grayish with white flecks and sometimes a narrow longitudinal line on middle of throat, which is also white; posterior part of belly and ventral side of limbs yellowish; iris brass-colored.

Measurements in mm. of cotypes: Head-body length, 35, 34; width of head, $14\frac{1}{2}$, 14; diameter of eye, 4, 4; diameter of tympanum, $3\frac{1}{2}$, $3\frac{1}{2}$; length of arm, 21, 21; length of leg, 64, $64\frac{1}{2}$; length of thigh, 21, 21; length of tibia, $21\frac{1}{2}$, $21\frac{1}{2}$; diameter of disc (4th toe), $1\frac{1}{2}$, $1\frac{1}{4}$.

Remarks: Boettger regards the species as being related to *Eleutherodactylus palmatus* Boulenger but differing in having the webs less developed, unemarginate tongue and in having an outer metatarsal tubercle.

He does not state that this species has vocal sacs, in fact he does not mention the sex; however, from the size of the tympanum (almost as large as eye) one is assured that at least one of the types is a male. Since the character is not mentioned as present or absent, one suspects that the types were not examined for this character. However, Günther (*loc. cit.*) states that vocal sacs are present in this species even in young males.

A series of specimens acquired on the northeastern slopes of the Cordillera Talamanca are referred to this species. They come from an elevation of approximately 6000-6500 ft. elevation. Most of the specimens were collected from under stones in open pasture areas

or along the roadside. The two largest males measure 47 and 48 mm., the females 61 and 75 mm. The following is a detailed description of the largest female specimen in the above series, K.U.M.N.H. No. 4986.

Description of species: Head broader than body, its length (26 mm.) less than width (29 mm.); snout rather short, truncate oval, the canthus rounded, the lores sloping obliquely to lip, the loreal region only slightly concave; length of eye (9 mm.) greater than the distance from eye to nostril (7.7 mm.), a little less than length of snout (9.4 mm.); tympanum higher than wide (4.4 x 3.5 mm.), separated from eye by 4.5 mm.; width of an eyelid equal to, or slightly greater than interorbital space; depth of head at tympanum 12 mm.

Vomerine teeth in two triangular fasciculi, their apices arising anterior to the posterior level of choanae, separated from each other by a distance equal to a sixth of transverse width of a fasciculus and from choanae by a third of this width; tongue rather large, broadly cordiform, slightly notched behind; less than a sixth free behind (males with elongate vocal slits but no external evidence of a vocal sac); choanae somewhat lateral, much smaller than the distinctly triangular ostia pharyngea; anterior border of choanae flare out somewhat.

Arm moderately long, the wrist reaching one third of the length of forearm beyond snout; inner fingers equal; the pads or discs well developed, but less than half area of tympanum in female (less than a third in male); the second and third fingers have a fringe or ridge on their inner border, representing a web remnant; subarticular tubercles somewhat elongated; a trace of supernumerary tubercles on hand; a prominent inner metacarpal tubercle; outer (palmar) tubercle large, low, partly bifid; male with prominent areas of nuptial tubercles on first finger and on metacarpal tubercle. Leg long, the heel reaching more than ten millimeters beyond tip of snout; when legs are folded the heels overlap two mm.; toes distinctly less than one-fourth webbed; the fringes extending on all toes to discs, the discs distinctly larger than those on fingers; a compressed, elevated, inner metatarsal tubercle; a small nearly obsolete outer metatarsal tubercle; subarticular tubercles elongated; a faint trace of an abdominal disc; a tarsal fold or ridge extending nearly half length of tarsus.

Skin above roughened, with pustules more distinct anteriorly, sides finely granular; chin, belly, and under side of limbs smooth, save below vent and on posterior face of thighs near vent; a strong, overhanging tympanic fold curving down (or angulate)

behind tympanum; a pair of tubercles between the tympanum and leg insertion.

Color nearly black with some variation in intensity visible when the specimen is submerged; sides lighter with some black spots; ventral surface dirty white, more pigment scattered on chin and throat than under arms, thighs, and abdomen; palms, soles and under tarsi black.

Some discrepancies between this description and the type description exist, but if Günther (*loc. cit.*) has identified the form properly, it is the only Costa Rican species of these very large frogs in which vocal slits are known to be present in the male; Günther figures a specimen that has a smoother dorsal surface than the one described. Some of the other specimens in the series show a much smoother condition of the dorsal skin.

Eleutherodactylus engytympanum (Günther)

Liohyla engytympanum Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1900, p. 224 (type locality, Monte Redondo, Costa Rica; C. E. Underwood coll.).

Diagnosis: A large frog (59 mm.); canthus distinct; tympanum an irregular oval higher than long, barely half area of orbit in female; choanae wider than ostia pharyngea; hind limb with tubercles and granules; digital discs equal, rounded, moderately developed; first finger longer than second; a rudimentary web between three inner fingers; toes one-fourth webbed; yellow vertebral line; yellow gular line.

Description of species: "In general habit and form of the head similar to *L. rugulosa*. Snout rather obtuse, with the canthus rostralis distinct, and with sloping sides; eye scarcely equal to its distance from the nostril. *Tympanum an irregular oval, deeper than long, barely half the area of the orbit* (in adult female). Vomerine teeth in two short prominent transverse series, slightly separated from each other, behind but within the level of the choanae; choanae rather wider than the Eustachian openings. Upper and lateral parts of the body, supra-orbital region, and upper parts of the hind limbs with tubercles and granules; a glandular fold above the tympanum; abdomen smooth, with indistinct granules on the sides; transverse and longitudinal folds indicate the presence of an abdominal disk. Length of the body a little less than the distance between vent and heel. Disks of fingers and toes subequal, rounded, moderately developed; first finger rather longer than the second; a rudimentary web between the three inner fingers. Metatarsals without pads, except at the base of the inner toe; outer metatarsal tubercle scarcely

visible; a tarsal fold. Toes one-fourth webbed. Greyish, with a yellow vertebral and gular line; an indistinct dark interorbital cross-band. Upper lip and flanks with blackish spots. Upper parts of the limbs obscurely banded; hind part of the femur rather finely and conspicuously marbled with black and white. Lower parts white. (One adult female.)

Measurements in mm. of one adult female: "Length of the body 59; distance between vent and heel, 62; length of foot, 47."

Eleutherodactylus talamancae Dunn

Figure 33

Eleutherodactylus talamancae Dunn, Occ. Papers, Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 385-386 (type locality, Admirante, Bocas del Toro, Panamá, Dunn and Duryea colls. Also reported from Monteverde, Zent and Suretka in Costa Rica); Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, p. 108. (From Chiriquí Lagoon in western Panamá north to Bluefields, Nicaragua; lower Reventazón, Costa Rica); Gaige, Hartweg, Stuart, Occ. Papers Mus. Zool. Univ. Michigan, No. 357, 1937, p. 6 (Río Mico, Nicaragua).

Diagnosis: Elongate head; fine granular corrugation on the dorsal surface of body and limbs; small vestige of web on foot; large finger discs on the *two* outer fingers, discs small on two inner fingers; vocal



FIG. 33. *Eleutherodactylus talamancae* Dunn. K.U.M.N.H. No. 28355, Turrialba, Costa Rica. Actual snout-to-vent length, 29.5 mm.

sacs present in males; heel reaching beyond the snout; females reach a size of 47 mm., males, 29.5.

Description of species: (K.U.M.N.H. No. 28355 Turrialba, Costa Rica.) Head narrow, oval, its length (13 mm.) greater than its width (11 mm.); in male, head wider than body, in female about same width; snout broad, the distance between nostrils (3.2 mm.) equals interorbital distance; lores somewhat concave, areas about nostrils swollen, with a slight depression between and on tip of snout; tip of snout extending about 1 millimeter beyond edge of lip; eye length (4 mm.) minutely greater than distance between eye and nostril (3.9 mm.); snout length, 5.3 mm.; tympanum (♂) large, a little longer than thigh (2.8 mm. x 2.3 mm.), its length .7 of eye length; a strong supratympanic fold curves down from eye to above arm insertion; an elongate tubercle behind jaw angle extending on lower jaw; width of an upper eyelid slightly less than interorbital width; vomerine teeth in two elevated somewhat triangular fasciculi between inner level of choanae but extending considerably behind posterior level, but not out to inner level, separated by less than half the length of one fasciculus; tongue subcircular a little longer than wide, not emarginate behind, free for only one fourth or less of its length. (In a paratype specimen E.H.T.-H.M.S. No. 29873 the fasciculi are a little larger and the tongue has a small posterior notch.) Choanae rather large, largely lateral in position; vocal sac present, not evident externally; a pair of elongate vocal slits.

Arms short, the wrist reaching tip of snout; first finger as long as second, thickened at base (♂) with a nuptial pad above the joint; subarticular tubercles present, large; supernumerary tubercles present but very indistinct; a large inner metacarpal tubercle at base of first finger; a relatively small outer palmar tubercle, bifid or tripartite; discs on two inner fingers small, distinct; those on two outer fingers large, half length of tympanum.

Legs long, the heel reaching four millimeters beyond tip of snout; no inner or outer tarsal tubercles or folds; subarticular tubercles distinct; no trace of supernumerary tubercles; a moderately large inner metatarsal tubercle, a small distinct outer; a trace of a web between inner toes, practically wanting between two outer toes; discs on middle toes equally as large as those on outer fingers, those of inner and outer toes smaller than other three.

Skin above finely corrugated, relatively smooth on top of head; rump slightly rougher; some of the slightly larger tubercles may tend to form rows; a very indistinct lateral fold; chin, breast and venter smooth; sides distinctly and smoothly granular, the granules

encroaching but little on venter; a trace of a discoidal disc on belly; median part of ventral surface of thighs granular; area below and lateral to vent granular, extending on posterior part of thighs for nearly half their length; a line of granules on the dorsal surface of thigh; front face of thigh entirely smooth.

Color: Dorsal color in preservative dusky brown with a dim dark area between orbits across hand, anterior to which color is lighter brown with some dusky markings; some indistinct darker markings that tend to outline an hourglass-shaped area; posterior to sacrum two or three very indistinct, broken dark transverse lines; legs and arms with dusky cross bars; the posterior face of femur nearly uniform dark brown; underside of tibia with some dark marks; below grayish white, or with a moderate peppering of pigment irregularly distributed; underside of foot and palm purplish; a cream mark above arm and some diagonal lighter marking on sides, distinct near groin; tympanum brown, a dusky area on loreal region and a dark line follows supratympanic fold. In life, yellow-olive above, the occipital region darker; tympanum brown; legs banded gray and olive; chin, throat, and abdomen whitish to cream, posteriorly; a faint pinkish suffusion in groin; magenta on underside of tibia; light marks on sides yellow-cream.

Measurements in mm. of Eleutherodactylus talamancae

Museum number	K.U.	M.C.Z. Paratype	M.C.Z. Type
	28355 ♂	9972° ♀	9879 ♀
Snout to vent	29.5	34	46
Width of head	11	11.5	16.14
Length of head	13	14	20
Snout	5.3	6	8.5
Eye length	4	4.1	6
Tympanum length	2.8	2.1	3.2
Tympanum height	2.3	2.1	2.6
Arm	17	20	27.2
Hand	9.5	10	14
Leg	51.5	59	85
Tibia	17.2	20.6	30
Foot and tarsus	25.3	26	37

Remarks: I have examined two males of approximately the same size from the Morehouse Finca, approximately 4-4½ miles south, Turrialba. They were in brush 6 to 8 feet high and were discovered by tracing a loud "squawk" which at first was thought to be that of a *Hyla*. The specimens were not actually seen making the call.

However there appear to be areas of loose skin at the angles of the mouth suggesting paired vocal sacs.

Two paratypes have a considerable lot of pigment on entire ventral surface (the type is said to be white below).

I have seen certain other specimens: M.C.Z. No. 9879, the type, Almirante, Panamá Republic, 47 mm. snout-to-vent length; M.C.Z. No. 7952 Monteverde, Costa Rica 21 mm.; M.C.Z. No. 9786; M.C.Z. Nos. 9795-97, Suretka, Costa Rica.

The following localities are known in Costa Rica: Guápiles, Zent, Monteverde, Suretka and Turrialba.

Eleutherodactylus platyrhynchus (Günther)

Figure 34

Hylodes platyrhynchus Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug. 1900, pp. 230-231, pl. 67, fig. a (type locality, Costa Rica); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 436, fig. 318. (Costa Rica).

Diagnosis: Moderately large species, females 57 mm. (the type 56 ♀); males 42 mm.; *venter finely granulate or areolate* over a considerable part of its surface, (a character not exhibited by other large eleutherodactylid species occurring in Costa Rica). Head moderately broad in females, less so in males; tympanum in female little more than one third, in male, one half to three fifths length of eye; nearly smooth above with one or two short skin-folds from orbit; discs on digits large, truncate, those on fingers larger than toes; heel to nostril; olive to brown above, with some black markings; white below. Males with large vocal slits.

Description of species: (K.U.M.N.H. No. 28276 ♀, Isla Bonita Volcán Poás, Costa Rica.) Head as broad as body (usually broader in males), the length (22 mm.) slightly less than width (23 mm.); canthus distinct, slightly angulate near orbit, rounded for most part and curving; area about nostrils swollen, with a slight depression between and from which point snout slopes downward to tip; a slightly elevated median point immediately in front of depression; snout-tip rather rounded oval, projecting slightly beyond edge of lip (1.5 mm.); eye directed somewhat forwards; length of eye (6.2 mm.) greater than distance between eye and nostril (5.1 mm.); length of snout, 9.2 mm.; width of an eyelid (4 mm.) less than interorbital width (4.8 mm.); distance between nostrils 4 mm.; tympanum relatively small, its height greater than its length (3.2 mm. x 2.3 mm.); a discrete curving supratympanic skinfold obscuring upper posterior edge of tympanum. A glandular tubercle back of jaw angle; another glandular tubercle at end of curved supra-

tympanic fold; loreal region somewhat concave, surface roughened, sloping obliquely to lip posteriorly, anteriorly the jaw forming a distinct ledge (not well indicated in younger specimens); a distinct medial occipital depression formed by the elevated musculature surrounding it, in front of which is an irregular pustule and just at anterior level of eyes a pair of indistinct interorbital pustules;

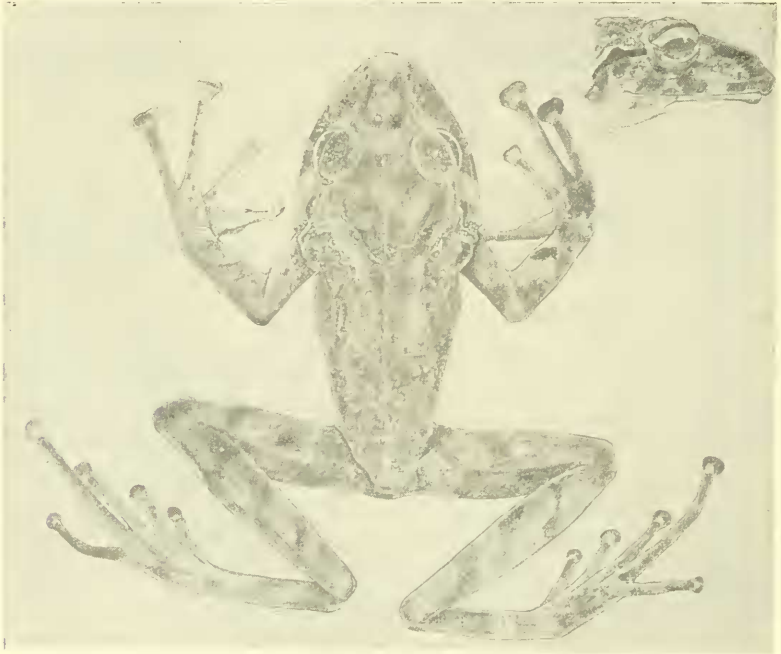


FIG. 34. *Eleutherodactylus platyrhynchus* (Günther). K.U.M.N.H. No. 28268; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 46 mm.

the raised occipital area outlined laterally by a pair of skinfolds that continue behind occiput; a tubercle on eyelid.

Choanae small, only partly lateral; vomerine teeth in two large triangular fasciculi very narrowly separated, the upper apices of triangles reach posterior level of choanae; but posterior transverse toothed edges much behind their posterior level (as well as the level of the transverse palatine ridges) and extending outward beyond inner levels of choanae; teeth 10-8; length of tooth-row 4 mm.; distance between choanae 3.6 mm.; tongue an elongate oval, little broader behind, not or but very slightly emarginate, free for approximately one fourth of its length.

Arm large, one half of forearm reaches beyond tip of snout, first finger much shorter than second; three outer digits with strong discs, somewhat truncate, showing (or not) slight emargination on their front edges, the discs much larger than tympanum; widest disc 3.2 mm.; subarticular tubercles large, rounded, elevated; supernumerary tubercles scarcely indicated; an elongate outer metacarpal tubercle at base of first finger; palmar tubercle large, rather indistinct, bifid or nearly so; three or four tubercles under arm in row; no web but fingers with slight lateral ridges.

Leg with heel reaching nostril; toes with large truncate discs, smaller on inner and outer toes, none as large as those on fingers; subarticular tubercles all well developed without trace of supernumerary tubercles; a large inner metatarsal tubercle, somewhat flattened, bearing a narrow free edge on outer anterior part; outer tubercle not or but faintly indicated (on most specimens no trace apparent); no tarsal fold or tubercle (certain specimens have a trace only of a tubercular fold). Web indicated, nowhere reaching posterior level of the subarticular tubercles but with a trace following digits on their sides as low ridges; heels overlap 5 mm. when legs are folded.

Skin of back and sides with some very fine granules and a few somewhat larger low pustular elevations; on sides general distribution of tubercular or pustular granules; the upper surface of limbs, front and most of ventral and much of posterior surface of thigh, smooth; chin smooth with some longitudinal wrinkling; outer and posterior surface of venter granular, the remainder of venter and breast wrinkled or smooth. A patch of granules on ventral and posterior part of thighs and to some extent on side of region of vent; some specimens have the upper surface of limbs showing small tubercle (especially males) (some specimens seem to have lateral ventral folds suggesting a discoidal disc); a tubercle on heel.

Color: Olive-brown above with some minute black spots on ridges or tubercles; arms indistinctly marked with dusky; legs strongly barred, three each on femur, tibia and tarsus; a dim dark line along upper edge of lores; a dark line widening to a spot above tympanum; a small oval black spot on tympanum but smaller than latter; three dark lip-spots with somewhat lighter centers; venter dirty grayish white (a fine equal distribution of pigment everywhere on surfaces of venter); posterior part of thigh barred; dorsal part barred but slightly lighter; some indefinite darker marks on upper part of sides.

Measurements in mm. of Eleutherodactylus platyrhynchus (Günther)

Museum number	K.U.M.N.H.	R.C.T.	R.C.T.	B.M.
	28276 ♀	2774 ♀	2763 ♂	Type
Snout to vent	57	46	42	56
Vent to heel	53	..	..	59
Length of head	22	17	16.5	..
Width of head	23	18	17	..
Length of snout	9.2	6.5	6.2	..
Eye length	6.2	5	4.8	..
Tympanum length	2.3	2	2.8	..
Tympanum height	3.2	2.6	2.9	..
Arm	35.3	32.1	27.2	..
Hand	20.1	15	13	..
Leg	90	79	69	..
Tibia	30	27	23.2	..
Foot and tarsus	44	38	32	..

Variation: In the material available to me are 25 specimens all taken at Isla Bonita. The following major color varieties appear.

R.C.T. 801 ♀. Side of head and body black; occiput and back deep rich wood-brown, faint indications of darker bars on legs. Magenta flecks on back of thigh and under tibia where the spots are distinct; venter dirty gray-white; feet below purplish; (in preservative less dark and some fine black dots border the dorso-lateral region); inner fingers light above. Only one specimen with this pattern.

K.U.M.N.H. No. 28267 ♀. Top of snout brown; a dark inter-orbital bar; beginning here a broad reddish clay stripe to end of body; fold with black edging; lip spots present and spot on tympanum; regular bars on gray thighs nearly obsolete, more distinct on tibia; below uniform grayish white. (Only one specimen with this pattern).

K.U.M.N.H. 28269 ♂, R.C.T. 2763 ♂, 2774 ♀. Dorsum rather lavender-gray, darker in interorbital region and lighter anteriorly; limbs indistinctly barred; lip spots not strongly indicated; venter gray-white, uniform or clouded under thigh; in one some darker flecks in a line dorsolaterally.

K.U.M.N.H. Nos. 28270 ♂, 28273 ♀, R.C.T. Nos. 2766 ♂, 2772 ♂. Dark lavender-brown above with a hair-fine tan line from snout tip to end of body; a white line across posterior surface of thigh; other typical markings present.

K.U.M.N.H. No. 28354 (35 mm. ♀ yg.). Rather typically colored above save that the black color following the occipital fold is more

intense and is bordered by whitish, which continues indistinctly back as two indefinite lines; spot on sides more intense; legs strongly barred with black; lower part of thigh black; areas without pigment on back and front of thigh between bars are cream yellow; whitish under tibia and foot and part of arm; dim lavender-red to magenta in axilla; snout magenta; pigment on venter segregated in many places in small black flecks or spots especially evident on under surfaces of thigh; under surface of feet, deep purple slate; hands similar, save inner fingers yellowish.

R.C.T. Nos. 803 ♂, 2775 ♀. These are dark blackish brown above with the typical markings on dorsum and sides; below nearly uniform blackish with some ashen flecks.

K.U.M.N.H. No. 28353 ♀. Light brown above with a light interorbital band followed by a darker area; a dim dark line crosses snout; a lighter reddish area above arm insertion; groin and lighter parts of hind legs, under and upper part of feet similar; back of thigh, chin, and venter whitish flesh; a pink spot on palm; bars on limbs very light brown, separated by whitish.

The structural characters of these specimens are not so variable: lack of webbing, size of discs, and length of limbs are generally constant; the vomerine series are smaller in younger specimens. The folds and tubercles differ somewhat from Günther's figure (*loc. cit.* pl. 67, fig. a). There the skin is shown with the folds not approximating each other to the same extent as in the figure given here, and there is less evidence of tubercles on back, and the banding on the thighs is more distinct. However all these characters depicted can be duplicated in other specimens at hand from the same locality.

Many of these specimens were taken in bromelias. Since there are no very young specimens in the collections I suspect that the young are largely or exclusively arboreal in habit. Since the two smallest (and youngest) specimens exhibit the brightest colorations, reds, magentas, and yellows, I suspect that these colors may be prevalent in the very young.

The details of significant structural characters are repeated so faithfully that on the evidence at hand one can scarcely regard these striking color differences as anything other than color variation.

The large female described herein contained an adult salamander *Magnadigita subpalmata* in the stomach.

Eleutherodactylus nubilus (Günther)

Figure 35

Hylodes nubilus Günther, *Biologia Centrali-Americana; Reptilia and Batrachia*, Feb., 1901, p. 237, pl. 69, fig. a (type locality, Escazú, Costa Rica; C. E. Underwood, coll.).

Diagnosis: Body rather slender; head flat, moderately wide; lacking web on hand and feet; discs on fingers and toes developed, former larger; abdomen smooth; choana and ostia pharyngea equal in width; skin above smooth or with some short narrow glandular folds; first finger longer than second; a tarsal fold; no subarticular tubercles on metatarsals; dark purplish with some darker clouding forming four indistinct longitudinal bands.



FIG. 35. *Eleutherodactylus nubilus* Günther. Redrawn from Günther, *Biologia Centrali-Americana; Reptilia and Batrachia*, Feb. 1901, Plate 69, fig. A. Specimen from Escazú, Costa Rica. Snout-to-vent length, 44 mm. (?).

Description of type: "Habit rather slender, the length of the body equal to the distance between the vent and heel. Head flat, moderately wide; snout rather produced, with distinct canthus rostralis and subvertical sides. Tympanum half the area of the eye (in an adult female). Vomerine teeth in two short transverse series, rather approximate to each other, considerably behind the choanae, but within the level from their inner margins. Choanae and Eustachian tubes equal in width. Skin of the upper parts smooth, only the regions above the shoulder and behind the supraciliary show some small tubercles and short narrow glandular folds; abdomen smooth. Disks of the fingers small, but distinctly developed and larger than those of the toes; first finger longer than second. One metatarsal tubercle, a tarsal fold; metatarsals without subarticular tubercles. Dark purplish, clouded with darker, the darker parts concentrated in four indistinct longitudinal bands, the middle of which reach almost to the snout. Hind limbs and upper lip indistinctly cross-banded; thigh finely marbled behind with brown and whitish. Lower parts whitish, with small blackish-brown marblings, a band along the middle of the throat being pure white."

Measurements in mm.: Head and body, 44 mm.; hind limb, 78 mm.; distance between vent and heel, 43.5 mm.

Remarks: I have seen no specimens of this species.

Eleutherodactylus peraltae Barbour

Eleutherodactylus peraltae Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, pp. 30-31, pl. 4, fig. 1 (type locality, Peralta, Costa Rica, 500 m. elevation).

Diagnosis: "A small species with broad, flat head, very long limbs, small disks and very small groups of vomerine teeth. Tympanum large and very near eye.

Description: "Vomerine teeth in two very small groups within the inner margin of the choanae, the anterior border of each group lying just ahead of a line connecting the two choanae; the groups widely separated, farther from each other than from either choana, separated by a distance equal to the length of one of the groups; snout long and depressed; nostril nearer to tip of snout than to eye, separated from eye by a distance considerably in excess of the latter's diameter; interorbital space slightly wider than the upper eyelid; tympanum ill defined, rather small, between one half and one third the size of eye, separated from the eye by a distance about equal to its own diameter; fingers slender, with medium disks; disk of fourth finger distinctly largest; first toe rather short,

slightly shorter than second, which again is slightly shorter than fourth; toes long, slender, free, first toe with very small disk, second and third with disks distinctly successively larger; subarticular tubercles well developed; sole almost smooth; a larger inner and small outer metatarsal tubercle; the hind limb being laid forward along the body, tibio-tarsal articulation reaches well beyond the tip of snout; heels overlap considerably when the hind limbs are placed vertically to the body axis; skin smooth above; smooth on throat and chest; coarsely granulate on abdomen and sides of thighs.

Color: "Above brown, beneath yellow; femores with four, tibiae with four, tarsus with two indistinct dark crossbands.

Measurements in mm.: "Tip of snout to vent, 27; width of head, 10.5; fore limb, 16; hind limb, 47; tibia, 17.5 mm."

Remarks: I have seen no specimen that I am able to refer to this form with assurance.

Eleutherodactylus euryglossus (Cope)

Lithodytes euryglossus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, pp. 196-197 (type locality, San José, Costa Rica. Sen. P. Biolley coll.).

Diagnosis: A large species (75 mm.); heel reaches between eye and nostril; tympanum a vertical oval its height $\frac{2}{3}$ eye (♀ ?); tongue openly notched; vomerine teeth in line with back level of choanae; ostia pharyngea larger than choanae; discs distinct, small; digits lacking dermal margins; first and second fingers equal.

Description of species: "A large species with small pallets, in which the heel does not reach the end of the muzzle, although it extends to a point anterior to the eye. General appearance that of a *Leptodactylus*. No distinct canthus rostralis; end of muzzle sloping backwards from lip-border. Tympanic disc a vertical oval, of which the long diameter is two-thirds that of the eye. Nostril nearer the end of the muzzle than its distance from the orbit. Tongue wider than long, openly notched posteriorly. Choanae moderate. Vomerine teeth in two transverse series, on transverse ridges whose anterior borders are in line with the posterior borders of the choanae, and whose external borders are a little within the internal borders of the choanae. Ostia pharyngea larger than choanae. Pallets distinct but shall, smallest on the manus. Digits without dermal margins. First and second fingers equal. Integument everywhere smooth. A discoidal abdominal fold. A fold on the distal half of the external border of the tarsus, extending to a rather prominent praehallucal tubercle.

"Color above, brownish lead-color; below whitish. Groin reticulate, and sides punctate with the dorsal on the ventral color. Four brown spots on the upper lip anterior to the line of the tympanum,

and a black streak above and behind the tympanum. A blackish cross-band between the posterior parts of the orbits, and some black longitudinal spots on the dorso-lateral region, bounding upwards the paler color of the sides. Limbs with obscure blackish cross-bands. Thighs behind, whitish at base, and obscurely reticulate on the superior and distal portions. Limbs below, and gular region, clouded."

Measurements in mm.: Total length of head and body, 75 mm.; head to line of canthus oris, 19; width of head at canthus oris, 28; length of anterior limb, 40; length of head, 18; length of posterior limb, 115; length of hind foot, 50; length of astragalo-calcaneum, 20.

Remarks: "This is the largest species of *Lithodytes*, but it is less robust than the *L. gulosus* Cope. In general appearance it resembles one of the large species of *Leptodactylus*, but it is a true Hyloidine, with T-shaped terminal phalanges. It has some resemblance to *L. melanostictus*, but that species has much longer hind limbs, larger pallets, an oval tongue, etc. A single specimen of the *L. euryglossus* is in the collection, which was taken at San José, by Sen. P. Biolley (No. 448)."

I have not been able to recognize this species in the material at hand.

Eleutherodactylus florulentus Cope

Lithodytes florulentus Cope, Proc. Amer. Philos. Soc., vol. 31, Nov. 17, 1893, pp. 336-337 (type locality, Boruca, Costa Rica. G. K. Cherrie coll.).

Diagnosis: Heel not reaching anterior edge of eye-orbit; vomerine tooth-rows close together; digital dilations small; head short, depressed canthus not distinct; tympanum (probably) a vertical oval, about half of the length of eye opening; two metatarsal tubercles; tubercles under fingers flat, less distinct on toes; venter smooth gray, the posterior face of leg black, cross-banded with dark, separated by scarlet areas; posterior sides and anterior abdomen blackish or brownish with crimson or orange spots. Length 35 mm.

Description of species: "The only specimen of the *L. florulentus* is damaged as to the integument of its head, which has been destroyed by agencies unknown to me. The skull with its muscles, and the rest of the body with the integument, are preserved. The head is short and depressed, and the canthus rostralis is not distinct. The length of the muzzle from the nostril to the orbit is about equal to the anteroposterior diameter of the latter, and the nostril is quite near the end of the nose. The tongue is subround, and is a little wider than long in its present condition. The internal nares are well forward; and the vomerine teeth are in two fascicles which are

close together, and are so far posterior to the nares as to be in transverse line with the palatine ridges. They are also as far as their own diameter within the anteroposterior line of the internal nares. The ostia pharyngea are narrow slits about as long as the nares. The tympanic drum is destroyed, but the space for it is a vertical oval, with about half the anteroposterior diameter of the orbit. The heel of the extended hind limb reaches the anterior border of the orbit. The extremital dilations are very small. There is a rather large oval internal or prehallucal tubercle which is entirely sessile; there is a small external tubercle. There are two palmar tubercles, and those of the anterior digits are distinct but flat; those of the posterior digits are less distinct. The integuments of the inferior and concealed surfaces are smooth; on that of the back a few small tubercles are present.

Color: "The color of the upper surfaces is gray dusted with blackish. The inferior or posterior surface of the hind legs is black, and this color is continuous with dark-gray cross-bands which cross the superior faces of the tibia and femur, four over each. The spaces between these cross-bands are scarlet. The posterior part of the sides and anterior part of the abdomen is blackish to brownish with crimson and orange spots of various sizes and shapes, the largest in the groin. Three cross-bands on upperside of foot, and three across forearm. Coloration of head unknown. The only specimen of this handsome species contained in the collection is from Boruca, and is No. 327.

Measurements in mm.: "Total length of head and body, 35; length of head to posterior line of tympanum, 12.5; width of head at posterior line of tympanum, 15; interorbital width, 3.5; length of fore limb 20; length of fore foot, 9; length of hind limb from groin, 51; length of hind foot, 24; length of tarsus, 9."

Remarks: I have not examined a specimen of this form. I doubt that it has been retaken.

Eleutherodactylus gaigei (Dunn)

Lithodytes gaigei Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 387-388 (type locality Fort Randolph, Panamá Canal Zone. Also reported from Barro Colorado Island, Canal Zone; and Talamanca Valley, Costa Rica. The species is named for Mrs. Helen Gaige. Perhaps the name should be corrected to *gaigeae.*); *idem, ibid.* Oct. 10, 1931, p. 410; *ibid.* vol. 8, June 7, 1933, p. 67 (El Valle de Anton, Panamá).

Diagnosis: Related to *Lithodytes lineatus* of South America but differing in having head wider than body; no flash markings on thigh or in groin; vomerine teeth oblique rather than transverse; dorsolateral light line from eye to sacrum.

Description of type: "M.C.Z. no. 10011: head a rather pointed oval; snout flat above, pointed; canthus rostralis angular; lores sloping steeply; upper eyelid less than interorbital diameter; eye equal to its distance from nostril; tympanum $\frac{1}{2}$ eye; heel to between snout and eye; head wider than body; disks of fingers and toes equal, about half again diameter of digit, much smaller than tympanum; fingers and toes free; a large inner and small outer metatarsal tubercle; a tarsal fold; finger I about equal to finger II; toe III equal to toe IV; smooth below, uniformly and finely rugose above; vomerine teeth in two oblique groups, equally in and back from choanae, separated by diameter of choanae and distant from choanae by same distance; dark brown, lighter below; a light line from eye to sacrum, snout to vent 38 mm."

Remarks: Dunn reports two small specimens from Talamanca, M.C.Z. Nos. 9901, 9904, 21 mm. and 18 mm. long, respectively. "They are black above, slightly lighter below, and the dorsolateral light lines begin on the snout where they meet. The vomerine teeth cannot be made out. In one the first and second fingers are equal and the third toe is shorter than the fifth, in the other the first finger is the shorter and the third toe is equal to the fifth."

I have not found this species in Costa Rica. I have examined the female type of this species but have not dissected it. The following characters were noted: choanae distinct, somewhat rounded; the vomerine teeth in two diagonal (not transverse) series, beginning anterior to back level of choanae converging somewhat, separated from each other by a distance greater than their distance from choanae; tongue largely free behind; snout rather long; the width of an eyelid about equal to interorbital space; diameter of tympanum contained approximately $1\frac{1}{5}$ times in length of eye.

First finger a little longer than second; hand with four supernumerary tubercles, six on foot; metacarpal tubercle rounded, distinct; palmar tubercle completely divided, the medial portion elongate; foot with trace of webbing; discs small; a large inner metatarsal tubercle, outer less than half as large; no fold evident on tarsus. Color blackish with thin dorsolateral white lines; whole underside cinnamon-brown.

FAMILY CENTROLENIDAE Taylor

Centrolenidae Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 36.

This recently proposed family of frogs extends in the Western Hemisphere from Central Veracruz and Guerrero in Mexico, to Perú and Argentina in South America. The members of the family

may readily be recognized by the presence of a single bone in the third (tarsal) segment of the hind leg. This is the result of the fusion of the astragalus and calcaneum into a single elongate element, similar to the fusion of the tibia and fibula in the adjoining segment.

One may postulate that the original, primitive condition is the separation of these bones into two elements. One would then conclude that the Centrolenidae represent a group that has relatively recently developed this character and are highly specialized. The tarsal characteristics of the ancestors of the present day Salientia is not known with certainty, but the oldest known Salientia have completed the fusion of the radius and ulna, as well as that of the tibia and fibula, and a fusion of the elements of the urostyle. An American fossil species, tentatively referred to the family Pelodytidae, also displays a fusion of the astragalus and calcaneus. Whether or not this ancient process of fusion once begun, extended to the tarsal elements in the ancestral salientian form, is not known, but it may be regarded as probable. The loss of the tail and the assumption of the leaping habit may conceivably have been the selective factors responsible for the re-separation of the two elements. This latter suggestion may not be sound, since to be fact, it would appear to demand the reversibility of an evolutionary process.

The Central American species of this family usually are green in life with or without indistinct markings of dark or lighter color on the dorsal exposed surfaces. The ventral surfaces are flesh or whitish flesh, the whole skin of the venter often being so transparent as to permit the discernment of the viscera. When placed in preserving fluids, the green disappears in a short time and a lavender or purplish pigmentation becomes evident on the dorsal surface of the body. This pigment may be equally distributed, or small, rounded, lighter spots, with little or no pigment, may be in evidence; the pigment may be segregated into small spots, or the groupings of the chromatophores may cause a pattern to be formed. The chromatophores vary in size and may disappear after a long time in preservation.

The black or white covering (tunic) of the eyeball visible through the upper eyelid, causes the lid to appear dark or light as the case may be.

KEY TO THE GENERA OF THE CENTROLENIDAE

1. Small species having a free tip on the pollex rudiment, with a spine emerging from it in the male. Costa Rica, Canal Zone, Panamá,

Teratohyla

2. Males with a process or "hook" on humerus visible externally; vomerine teeth usually present. Central America and northwestern South America *Centrolene*
 Males lacking the humeral process; vomerine teeth present or absent. Southern Mexico, Central and South America . . . *Cochranella*

GENUS CENTROLENE Jiménez de la Espada

Centrolene Jiménez de la Espada, An. Soc. Española Hist. Nat., vol. 1, 1872, p. 87.

Type of genus: *Centrolene geckoideum* Jiménez de la Espada.

A single species, *Centrolene prosoblepon*, belonging to this genus is known from Costa Rica. Its range is from 5,500 feet on Volcán Poás, to little above sea level near Limón, the type locality. Specimens have also been reported from Canal Zone and Panamá.

The type locality of *Hyla puncticus* is La Palma, Costa Rica, but until this type is compared by a competent observer with *prosoblepon*, it cannot be certain that the species should be regarded as synonyms.

Other known species of the genus are South American in distribution, the type of the genus being the largest known member of the family.

The curious humeral process, present in males of this genus is probably not normally present in females, although the condition has been reported in certain individuals.

Centrolene prosoblepon (Boettger)

Hyla prosoblepon Boettger, Katalog der Batrachier . . . Sammlung, im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main, Aug., 1892, p. 45 (type locality, Plantage Cairo [La Junta], near Limón, Caribbean side of Costa Rica. Carl Fleischmann coll.); Günther, Biologia Centrali-Americana. Reptilia and Batrachia, 1901, p. 280; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 256 (Costa Rica, Panamá).

Centrolene prosoblepon Noble, Proc. Biol. Soc. Washington, vol. 37, 1925, pp. 66-71 (numerous Costa Rican localities); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 398-399; *ibid.*, Oct. 10, 1931, pp. 415, 421. (Barro Colorado Island, Canal Zone); *ibid.*, vol. 8, June 7, 1933, pp. 73, 74; Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 258-259 (Isla Bonita, Volcán Poás, Costa Rica).

? *Hylella puncticus* Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 341 (type locality La Palma, Costa Rica, C. F. Underwood coll. Snout-to-vent length 26 mm.).

Diagnosis: A small frog, snout to vent, 26 mm.; green in life with the venter transparent flesh permitting a view of internal organs; tips of digits dilated into distinct disks, wider than fingers or toes, the tip rounded rather than truncate; vomerine teeth present; males with a humeral process or hook, not indicated in females; no web between first three fingers; between third and fourth about one

half webbed; heel to near nostril; smooth above, granular on venter; chin and breast smooth; interorbital distance equals eyelid; tympanum distinct, directed outward and slightly upward and backward; a pair of rounded moundlike tubercles on ventral side of thighs near the median line; a thickened tarsal fold; males with a large lateral somewhat diffuse gland. Males often with numerous minute white-tipped spinules on side of head and neck (probably a breeding phenomenon). Nearly uniform heliotrope or reddish lavender, with small rounded darker dots on limbs and posterior part of back (sometimes lacking on back).

Description of species: (K.U.M.N.H. No. 23806, Isla Bonita, Volcán Poás, 5500 ft.). Head length (9 mm.) less than head width (9.5 mm.); eyes large, strongly protruding directed somewhat forward; the eyelid equal to interorbital width (2 mm.); canthus rostralis distinct, rounding; areas about nostrils swollen with a depression between them extending length of snout; nostrils nearly terminal, but not extending forward to level of lip; tympanum distinct save that the upper part is covered by a thickened indistinct skin fold, its diameter (1.1 mm.) contained in eye length (3.8 mm.) 3.4 times; loreal region somewhat concave, sloping obliquely to lip; distance between tympanum and eye twice width of tympanum; length of eye (3.8 mm.) greater than snout length (2.8 mm.); nostril nearer median point of upper lip than to eye.

Tongue longer than wide, less than one fifth free behind; (vocal sacs elongate in males); choanae rather large, longer than wide, the width of one in distance between them approximately four times; vomerine teeth in two somewhat diagonal fasciculi, lying between choanae, separated mesially by a distance nearly equal to distance separating them from choanae; transverse groove of the palatal glands nearly straight, nearer choanae than anterior part of palate.

Arm strong, the hand large; fingers with terminal discs distinctly wider than digits; first finger distinctly longer than second, lacking traces of web between first three fingers; one-third webbed between outer fingers, with a slight fringe continuing to disc; inner metacarpal tubercle moderate without free tip or spine; humerus without hook (present in males); median palmar tubercle strongly defined, rounded.

Leg elongate the heel reaching approximately to nostril; discs on toes smaller than those on fingers, and that on first finger is somewhat pointed; other digits nearly truncate but slightly curving on ends; outer toes with web extending two thirds length of third and

fifth; first and second less than half webbed; elbow and knee overlap but if legs are folded the heels touch but do not overlap.

Skin smooth on dorsal and lateral surfaces save for some minute white-tipped tubercles below tympanic area; chin, breast, and underside of arms smooth, venter granular; much of the posterior part of ventral surface of thigh granular with a pair of large, moundlike tubercles near median line; some indistinct vertical wrinkles below anal region.

Color: Greenish in life on dorsal surfaces; ventrally yellow to transparent flesh; in preservation heavily pigmented with purplish lavender, the chromatophores segregated in places to form spots (which may be scattered on back and limbs); pigment less distinct above arms and legs but spots also present; ventral and concealed surfaces whitish flesh; concealed parts of eyeball blackish, thus leaving dark eyelids.

Measurements of Centrolene prosoblepon (Boettger)

		Total length	Head length	Head width	Arm	Hand and fingers	Leg	Foot and toe	Tibia	Femur
23806	♀	27.5	9	9.5	18	8.5	46	20	15	15
793°	♀	26.5	9	9.8	16	10	46.2	20	15.2	15
2922	♂	26.5	8.4	9.2	18	8	46	19	14.6	13
23804	♂	26	8.3	9	17	8	46	19.4	14.6	13
2926	♂	25	8.3	9	17	8	46	19	14.4	14
23803	♂	25	8.2	9	16	8	45	19	14.2	13.8
23805	♂	24	8	8.5	17.5	7.9	43	19	14	12.8
794	♂	23.4	7.9	8.5	17	7.8	43	19	14	13
Type	..	24.5	7.5	9	14.5	..	42	..	..	..

Remarks: A series of eight specimens from Isla Bonita (The American Cinchona Plantation), display varying shades of lavender, and different degrees of spotting.) Two females, the largest specimens, have the darkest shade of lavender. The exposed surfaces of the back and limbs have small, rounded, purplish or purplish-brown spots. The males, which on the whole are of a light shade of lavender, have the spotting similar to that in the females in two specimens, while in four the spots are fewer in number and confined to the rump and dorsal surfaces of the limbs.

The largest male, with a very well-developed humeral process, has no trace of vomerine teeth; but they are present in all other specimens examined. The two females show no trace of the humeral process.

° Nos. 793, 794, 2922, 2926 are field numbers of R. C. Taylor; others are K.U.M.N.H., all from Isla Bonita, Volcán Poás.

The measurements of the type, as recorded in the type description, is appended to the table of measurements. It may be noted that the measurement of the arm of the type is considerably smaller than that of specimens of smaller snout-to-vent measurement in this series; the leg is slightly smaller, the head length a little shorter, and the head width a little greater. The differences may be due to a different technique of measurement.

The type is from near sea level while the specimens listed in the table come from an elevation of about 5,500 ft. on Volcán Poás. Whether or not direct comparison with the sea level population would reveal other significant differences cannot be stated now.

A single specimen was taken in 1951 at Moravia; the vomerine tooth fasciculi are present. Externally the vocal sac is evidenced by two small pouches which seemingly are separated. The spotting is sparse and confined largely to limbs and posterior part of dorsum. The head and remainder of the back are uniform purplish lavender.

Genus TERATOHYLA Taylor

Teratohyla Taylor, Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, p. 35.

Type of genus: *Centrolenella spinosa* Taylor.

A single species is known. It is related to other members of the family as *Plectrohyla* and *Hypsiboas* are to *Hyla*. The only species reaches a known length of approximately 21 mm. No females have been found, but it is to be expected that their size is two or three millimeters larger than males. The present known range extends from Costa Rica on the east slope, to Panamá and the Canal Zone.

Teratohyla spinosa (Taylor)

Figure 35a

Centrolenella spinosa Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 259-262 (type locality, Los Diamantes near Guápiles, Costa Rica. R. C. Taylor and E. H. Taylor colls.).

Teratohyla spinosa Taylor, Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, p. 35.

Diagnosis: A small species (about 21 mm.); snout high, the front edge nearly vertical; nostril near front edge of snout. Vomerine teeth very weak, usually present; tympanum present; skin minutely rugose but not granular on back and sides; a well-defined pollexrudiment bearing a sharp spine which may or may not be exposed; lavender without any spotting; eyelids purple; iris silver with purple reticulation; inner toe narrowed at tip.

Description of the type: Head broader than the body; eyes prominent, directed somewhat forward; canthus rostralis apparent, very

much rounded; areas about nostrils much swollen with a distinct medial depression between them; loreal region with a long slope to lip, the area behind nostril slightly concave; snout in front of nostrils nearly vertical, the nostrils much nearer median point of upper lip than eye; interorbital width greater than the length of snout, one and three-fourths times width of an eyelid; tympanum present, its greatest diameter about one and three-fourths times in its distance from eye, almost three times in longitudinal diameter of eye; a rather marked constriction of head behind tympanum, with a somewhat swollen area above arm insertion; supratympanic fold



FIG. 35a. *Teratohyla spinosa* (Taylor). Type K.U.M. N.H. No. 23809 ♂; Los Diamantes, Costa Rica; actual snout-to-vent length, approximately 20 mm.

obsolete; tongue rather rounded with a scarcely discernible notch behind, free behind for about one fifth its length; openings to vocal sacs elongate, curved slits, beginning along sides of tongue and extending some distance behind; choanae large, round, the diameter of one contained in distance between them three times; external vocal sac forming ample folds on chin.

Upper arm very slender, the forearm greatly thickened with an indistinct flattened skin-fold on under surface; only a faint trace of web between the first and second fingers; a small but distinguishable web between the second and third with a moderate fringe reaching terminal pad on outside of second finger; third and fourth fingers about half webbed, the web not reaching the level

of the outer subarticular tubercles; fingers widened at tips, and more or less truncate; first finger much longer than second with a distinct rudiment of pollex, free at tip, with a sharp, strong spine (possibly absent in female; none seen); pollex surrounded by the elongate palmar tubercle; a strongly defined, rounded, median, palmar tubercle; subarticular tubercles well defined and numerous; supernumerary tubercles present; legs long, the tibiotarsal articulation reaching slightly beyond snout-tip when limb is adpressed; the heels touch but do not overlap; foot a little more than three fourths webbed, the terminal pads smaller than those on fingers, the outer somewhat truncate, that on inner toe somewhat pointed, scarcely or not as wide as toe; moderate inner metatarsal tubercle elevated but little; apparently no trace of an outer tubercle; subarticular tubercles small, supernumerary tubercles not or scarcely discernible; inner tarsal fold very weak, scarcely discernible; anal opening high on rump covered by a free flap, the transverse free edge much longer than width of flap.

Skin on back and sides seen under a lens, minutely rugose, but definitely not granular; belly and under side of thigh strongly granular, the granules of the latter much the larger.

Color: In life, yellow-green except concealed surfaces of arm, leg, and under side of body which are flesh-white, and transparent, without markings; a large light cream spot in front of arm insertion. In preservative (formalin, then alcohol) the dorsum nearly uniform lavender, the eyelids deep purple; limbs lighter but with a fine peppering of lavender chromatophores on the exposed surface, even on upper surface of the thigh; below and on concealed surfaces pure white without pigment; iris of eye silver with purple venation; upper lip white.

Measurements in mm.: Snout to vent, 20; width of head, 7; arm, 13; leg, 35.5; axilla to groin, 10.2.

Variation: The five paratypes are all males and agree with the type in essential details, such as in the constriction of sides of head behind the tympanum, forward position of nostril, and the narrow tips of inner toes; the vomerine teeth appear to be present in all but are completely transparent and scarcely discernible save under magnification.

The spine of the pollex is transparent, sharp, and in certain cases, does not seem to have pierced the surface of the skin. I presume that this serves as a "grasping" organ in clasping and that the spine pierces the skin surrounding it during this act. If the spine is present in the female it will probably be found to be much reduced. The base of the first finger lacks nuptial asperities although under

a lens one can discern a group of small spherical glands below the skin in the region where they normally occur in certain other species.

This genus stands in relation to *Cochranella* much as *Plectrohyla* does to *Hyla*.

Specimens were taken at night during a rain. They were calling from plants along a forest rivulet.

Genus COCHRANELLA Taylor

Cochranella Taylor, Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, pp. 34-35.

Type of the genus: *Centrolenella granulosa* Taylor.

Eight species are recognized in Costa Rica. All these are diminutive frogs not known to reach a size greater than 28 mm. Most of them are greenish in life on the dorsal surfaces of body and limbs, while the venter may be cream, white, yellow or transparent flesh. They are found perched on leaves of trees or plants near running water. Eggs are probably always laid on leaves above water, and this is certainly known to be the case in two members of the genus.

One specimen taken during the daytime was found attached to the under side of a leaf surrounded by a mucouslike covering. Eggs were found above the water on leaves of *Bryophyllum* or other plants growing along the edges of small rivulets.

KEY TO COSTA RICAN SPECIES OF COCHRANELLA

- | | |
|---|---------------------|
| 1. Vomerine teeth absent | 2 |
| Vomerine teeth present | 6 |
| 2. Area about nostrils not swollen, not projecting beyond lip; tympanum hidden; no web between first two fingers; heel not reaching beyond tip of snout | 3 |
| Area about nostrils swollen, not, or more or less, projecting; heel reaches beyond tip of snout; tympanum visible | 4 |
| 3. Cover of eyeball black, the upper eyelid appearing dark; heel reaching tip of snout. San José and Alajuela | <i>chrysops</i> |
| Cover of eyeball white; upper eyelid appearing largely white; heel reaching to anterior edge of eye; diameter of the choanae in distance between choanae about three times. Central America to Mexico | <i>fleischmanni</i> |
| 4. Tympanum small $\frac{1}{3}$ to $\frac{1}{6}$ of eye length; snout strongly projecting, a green median stripe. Costa Rica | <i>valerioi</i> |
| Tympanum larger, its upper edge may be indistinct, its diameter in eye contained 2.5 times or less | 5 |
| 5. Tunic of eye light; a greenish median line present with series of small rounded light spots more or less arranged in rows; no strong folds behind vent. Choanae moderate. Moravia, Costa Rica | <i>talamancae</i> |

- Tunic of eye dark, strong folds on thighs below or behind vent; no dorsal stripe or defined white dots. *colymbiphyllum*
6. Skin on dorsum smooth; tympanum "small"; no web between first two fingers; outer finger about four fifths webbed; toes completely webbed; nostril?; tip of snout?; dorsum with minute dark flecks and scattered white punctations. Reported from Bebedero and Turrialba *pulverata*
- Skin on dorsum more or less granular; nostril equidistant or nearer to eye than median edge of lip; vomerine teeth weakly developed; tip of snout sloping forward obliquely. 7
7. Skin of dorsum strongly and regularly granular; web remnant between first and second fingers; outer fingers two thirds webbed; toes three fourths webbed; eyelid purple; body (in alcohol) creamy white with numerous fine chromatophores and numerous larger punctations of dark purple; 28 mm. Los Diamantes *granulosa*
- Skin of dorsum indistinctly granular on posterior part, slightly rugose on sides and head; vomerine teeth strongly developed; heel 4-5 mm. beyond tip of snout; eyelid equals interorbital width; purplish lavender above with numerous rounded cream or white spots; 27 mm. Los Diamantes. *albomaculata*

Cochranella chrysops (Cope)

Hylella chrysops Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, p. 196 (type locality, Alajuela, Costa Rica, R. Alfaro, coll. and San José, Costa Rica, P. Bolley coll.) (Here restricted to San José, Costa Rica.)

Cochranella chrysops Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 35.

This species, which in the more recent literature has been placed in the synonymy of *Centrolenella fleischmanni* Boettger, is, I suspect, a species distinct from *fleischmanni*. One of the most striking characteristics of the latter is the white covering of the concealed parts of the eyeball which produces a silvery white or cream white marking through the upper eyelid. In *chrysops* the covering of the eyeball is dark, and the upper eyelid appears dark because it is semitransparent; a comparison of specimens of the two forms shows the legs of *fleischmanni* slightly longer, reaching the tip of the snout or usually a little beyond tip. There are no vomerine teeth. Cope's original description follows:

Description of type: "Head short, wide, canthus rostralis wanting. Tongue a little longer than wide, faintly emarginate; ostia pharyngea each a transverse slit. Tympanum not visible. Pupil a dumb-bell-shaped horizontal slit in the golden iris. Heel of extended hind limb reaching to end of muzzle. The muzzle is as long as the diameter of the eye, and does not project beyond the lips; nostrils terminal. The fingers are one-third webbed, the thumb free, and at least as long as the short third (second) digit. Hallucal tubercle minute; pallets well developed.

Color: "Above and below yellow; pigment more conspicuous on edges of eyelids. No markings of any kind except that one specimen is covered above with rather distinct, minute, black specks."

Measurements in mm.: Total length, 22; head to mouth angle, 6; width of head, 8; arm, 13.5; hand, 6; leg, 36; foot, 15; tarsus, 7.

Remarks: Cope compares his species with *Hylella platycephala* (= *sumichrasti*) of Mexico; but it is not related to that species. The relationship of *chrysops* is presumably with *fleischmanni* which likewise has the tympanum concealed.

From *colymbiphyllum*^o it differs in having the tympanum concealed, a narrower interorbital interval in comparison to the width of an eyelid (in *chrysops* the eyelid is contained twice or slightly less than twice in this distance, while in *colymbiphyllum* 1.25 times); the areas about nostrils are not conspicuously swollen. *Chrysops* is a smaller species (maximum seen, 23.5 mm.).

Cope states that the specimens are yellow above and below. If this color is that of living specimens, this will constitute another difference between *chrysops* and *fleischmanni*. However, I suspect that they are green in life, as are most if not all other Costa Rican species of this genus.

During the summer of 1951 I spent some time in the region about Alejuela and Río Segundo in hopes of obtaining specimens of this form, but my efforts were of no avail.

Cochranella fleischmanni (Boettger)

Hylella fleischmanni Boettger, Senckenberg Naturf. Gesellsch. 1893, pp. 251-253 (type locality, San José, Costa Rica, Carl Fleischmann coll.); Boulenger, Zool. Rec. 1894, Rept. p. 41; Günther, Biología Centrali-Americana; Reptilia and Batrachia, 1901, p. 287, pl. 73, fig. D (San José, La Palma, Alejuela); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 255; Taylor, Univ. Kansas Sci. Bull., vol. 28, pt. 1, May 15, 1942, p. 74; Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, p. 601 (Salto de Agua, Chiapas, Mexico.).

Centrolenella fleischmanni Noble, Proc. Biol. Soc. Washington, vol. 37, 1924, p. 69; Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, 1949, pp. 264, 265.

Cochranella fleischmanni Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 34.

Diagnosis: A small species (22 mm.-25 mm.), with rounded snout and without canthus rostralis; tympanum completely concealed; no vomerine teeth, nostrils not swollen; green in life, with a cream-white to golden yellow area covering eyelid and concealed parts of eyeball; chromatophores scattered over the flesh-colored dorsum in preserved specimens; without web between first two fingers; small web at base between second and third; outer toes half

^o The diving leaf.

webbed; skin smooth or granular (?). The white spot above eye is not lost in preservation. Vomerine teeth absent.

Description of species: (K.U.M.N.H. No. 23807.) Head width (9 mm.) greater than its length (7 mm.), the head definitely rounded in profile seen from above, the nostrils barely breaking the outline of the jaw; tympanum concealed, rarely visible when specimens are shrunk or dried; canthus rostralis absent (or very broadly rounded), the loreal region concave and sloping to edge of lip; eye large, directed considerably forward, its length (2.3 mm.) greater than snout length (2.1 mm.); nostrils closer to median point on lip than to eye not projecting when seen in lateral profile, the front of the snout almost vertical to lip, not sloping obliquely; width of an eyelid (1.1 mm.) in interorbital width (2.4 mm.) more than twice; a slight depression indicated between orbits; iris of eye clouded with purple. Choanae circular the diameter of one (.6 mm.) in distance between them (1.8 mm.) three times; no vomerine teeth; choanae of about same size as the openings of the Eustachian tubes; a sharp ridge borders anterior outer edge of the groove leaving the choanae; tongue a little broader than long not emarginate behind, free for about one sixth of its length; vocal slits large, elongate.

Arm rather long the fingers widened and truncate, with terminal discs not or scarcely wider than digit; first finger distinctly longer than second, none or but slight trace of a web between first and second finger; between second and third about one third webbed the web continued as a broad fringe to disk on the outer side of second finger; outer fingers less than half webbed, the broad fringe continuing to the disc on the outer side of third finger; inner metacarpal tubercle elongate, flattened, without free tip or spine; median palmar tubercle well defined, circular; a distinct skin fold along outer ventral arm surface; subarticular tubercles well defined, none divided; numerous granulations on under side of hand.

Leg elongate the heel reaching a point immediately in front of eye; a sharply defined inner tarsal fold; and an indistinct outer fold may be present along part of the tarsus; toe discs smaller than those on fingers; toes two thirds webbed; inner metatarsal tubercle flat; outer tubercle small but distinct; when legs are folded at right angles to body, heels barely touch or fail to touch.

Skin above smooth but under lens shows fine granulation on dorsum and sides as well as on arms and parts of upper side of legs; a very ample smooth vocal sac on chin; breast smooth with a breast

fold indicated (males); venter coarsely granular, as is part of underside of femur where a few very large flat granules are present near median line; anal opening high, the area below vent somewhat wrinkled and granular.

Color: Greenish above in life with a creamy or yellowish-white spot on eyelid (actually the coloring is on the eyeball and not the skin). Below transparent flesh. In preservation body flesh-color with fine purple chromatophores scattered on dorsal surfaces and side of head; venter and concealed surfaces flesh color.

Measurements in mm.: Snout to vent, 24; snout to eye, 2.1; width of head, 9; length of head, 7; eye length, 2.3; arm, 14.3; hand, 7.2; leg, 39; tibia, 12.5; foot and tarsus, 16.

Remarks: This species has been traced north into Mexico. Most of the northern collections have been of single, or of very few, individuals. It is uncertain whether any significant differential characters obtain in the northern populations.

Eggs, of what was presumed to be this species, were acquired from a small shrub, growing over a small drainage ditch near Cartago, at an elevation of nine feet from the ground; adults of *fleischmanni* were taken in the immediate vicinity. The eggs are smeared over the surface of a partly folded leaf covering an oval surface 20 mm. long, 17 mm. wide, the individual eggs probably averaging 1.5 mm. in diameter. The mass includes a total of 53 eggs, all lying in the same plane. The eggs seemingly had just been deposited. Several other egg lots were observed on *Bryophyllum* growing on the edge of a small rivulet.

Three specimens were taken at Río Segundo, Costa Rica and others at Cartago. A dried specimen taken near Empalme by Mr. Jack Reark and presented to me, is believed to belong to this species.

One recently transformed specimen taken at Turrialba is also presumed to belong to this species, but this at best is uncertain. The largest specimen, a male from Río Segundo, measures 25 mm. On each side of the neck are enlarged swellings immediately above arm insertions. None of the other specimens taken there show such a development. Save for size I find no other pertinent differences.

Cochranella valerioi (Dunn)

Centrolene valerioi Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 397-400 (type locality, La Palma, Costa Rica. Manuel Valerio and E. R. Dunn, colls.); *idem*, vol. 8, June 7, 1933; ? Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 264-265.

Cochranella valerioi Taylor, Proc. Biol. Soc. Washington, vol. 64, April 13, 1951, p. 35.

Diagnosis: Vomerine teeth absent; nostrils swollen, protruding; snout projects in front of mouth; tympanum small, indistinct, covered with skin but more or less visible under skin; fingers $\frac{1}{3}$ to $\frac{1}{2}$ webbed; foot nearly $\frac{2}{3}$ webbed; heel to a point 2 mm. beyond tip of snout; vocal slits very short; maximum known size 21 mm.

Description of species: (From paratype MCZ. 16004, topotype.) Head (8 mm.) distinctly broader than body, and likewise greater than length of head (6.6 mm.); eyes very large the diameter (length) (2.8 mm.) greater than length of snout (2.1 mm.); distance between eye and nostril 2 mm.; distance of nostril to median point on upper lip 1.8 mm; canthus distinct but somewhat rounded, the loreal region concave, sloping obliquely to mouth; width of eyelid (1.5 mm.) in interorbital distance (2.3 mm.) one and one-half times; swellings about nostrils prominent, terminal, projecting, with a slight depression present dorsally and anteriorly between them, the nostrils actually in advance of the line of mouth; tympanum completely covered with skin, directed upward; when skin is lifted, the tympanum is of moderate size, its greatest diameter (.9 mm.) about a third of eye length; area between orbits somewhat concave. Vomerine teeth absent; choanae moderately large, longer than wide, the width of one (.5 mm.) contained in the distance between them (1.5 mm.), 3 times; tongue subcircular, thick, slightly broader than long, free behind for about one fourth of its length; vocal slits, small, nearly transverse; openings of Eustachian tubes less than half size of choanae.

Arm with wrist extending considerably beyond tip of snout; no axillary web. Fingers with slightly widened discs, truncate at tips; first finger a trifle longer than second, the web between first and second fingers about one fourth of their length; between second and third about one third the length of second; third and fourth toes webbed nearly one half length of fourth, but there is a strong fringe continued to the terminal phalanges of each; inner metacarpal tubercle slender elongate but lacking a free tip and spine; median palmar tubercle distinct oval, relatively small.

Leg long, the heel reaching beyond tip of snout, the elbow and knee overlap, but the heels where legs are folded barely touch; inner metatarsal tubercle elongate, inconspicuous; outer tubercle seemingly obsolete; toes webbed approximately two thirds of their length with a fringe continued to terminal phalanges on the inner side; no tarsal fold present.

Skin on head, dorsum, sides, chin, and breast smooth; venter finely granular on anterior part, coarsely granular posteriorly with

some indication of granulation on posterior median part of ventral surface of thighs; vent high on thigh with a short wide anal flap; skin below anus longitudinally (vertically) folded but the folds indistinct.

Color: Flesh white with practically no trace of pigment visible at the present time.

Measurements in mm. of type and paratype of Cochranella valerioi (Dunn)

	Type	Paratype
Snout to vent	21	20.8
Width of head	8	8
Length of head	..	6.6
Length of eye	..	2.8
Length of snout	..	2.1
Arm	13	14.2
Hand	..	6.2
Leg	39	38
Tibia	..	13
Tarsus and foot	..	16.5

Remarks: The coloration of the type is given as follows: "In life white, a narrow green dorsal stripe, green vermiculations on dorsal surface and on shin, thigh unpigmented, white beneath, iris golden; in preservative white, a few faint dark chromatophores where green was in life."

Differences between this specimen and the type are not marked but what seem to be differences may be due to other reasons. The tympanum is stated to be one sixth of eye, but I suspect that the measurement was made without removing the skin which covers it.

Cochranella talamancae sp. nov.

Type: K.U.M.N.H. No. 4143. Moravia, Costa Rica, Caribbean drainage; August 16, 1951, Edward H. Taylor, collector.

Diagnosis: Snout sloping abruptly to edge of lip but not extending beyond; vomerine teeth absent; tympanum present, more or less covered by skin but distinctly visible, largely directed upward; a whitish bar across head at narrowest point between orbits; general color greenish yellow with a reticulation of green, the green surrounding small rounded light spots more or less distinctly arranged in eight or nine linear series; a more or less distinct greenish median line; no anal tubercles or ridges; the bones are not green; eye surrounded by a white tunic.

Description of type: Small species (22 mm. ♂); head much broader than body; snout truncate; head much wider than long

with the large eye largely directly forward; tympanum distinct, covered with thin skin, its diameter in length of eye approximately 2.8 times; the distance between tympanum and eye distinctly greater than diameter of tympanum; length of eye distinctly greater than length of snout; top of head rather flat, sloping down slightly to base of snout; areas about nostrils swollen with a distinct depression between; nostrils nearly terminal but not extending beyond the lip, a little closer to median point on lip than to eye; canthus more or less distinct, straight; eyelids narrow, contained in interorbital interval twice; choanae large, the diameter of one (.7 mm.) in distance between choanae (1.3 mm.) less than two times; no vomerine teeth; tongue a little broader than long, only the posterior edge free; vocal slits short, largely posterior to tongue and lying mediad a considerable distance from jaw.

Arm very slender, digits broad, rather truncate, the first finger longer than second; a small web between the first and second and second and third, with a narrow fringe reaching to discs on the outer edges of fingers; the web between the third and fourth fingers continues as a fine fringe on each digit, but web deeply excised between them (a little more than one third webbed); inner carpal tubercle discernible; a rounded palmar tubercle; other tubercles on digits and palms scarcely discernible.

Leg slender with a fused astragalus and calcaneum; a flat inner metatarsal tubercle; outer not distinguishable; toes a little more than three-fourths webbed, the tips slightly rounded; tips or discs of all digits equal to or less than width of digit. Tibiotarsal articulation to tip of snout; legs folded at right angles to the body, heels do not touch; elbow and knee overlap 2.5 mm.; a slight tarsal fold.

Skin above appearing smooth but under lens is minutely rugose; sides indistinctly granular; venter except breast and chin evenly granular; under surface of thigh with irregular granules; no especial folds or tubercles in region of vent.

Color in life: Above, the ground color is generally yellowish green to greenish yellow with a more or less distinct median green line, and a green reticulum that forms eight or nine more or less distinct but somewhat irregular linear series of rounded light spots; hands and feet flesh, with very slight yellowish wash; eye with a gold rim; iris reticulated purplish black and golden; below on venter greenish flesh, transparent so as to show details of viscera; an area on chin whitish flesh.

In preservative the green has wholly disappeared and a large number of purplish or lavender chromatophores are in evidence.

These are not equally distributed but leave numerous unpigmented light areas; golden band on eye-rim cream-white; upper eyelid purple and white; iris lavender with some whitish flecks.

Measurements in mm.: Snout to vent, 22; width of head, 8.6; length of head, 6.2; length of eye, 2.5; diameter of tympanum, .9; length of snout, 2; eye to nostril, 1.9; nostril to median point on lip, 1.75; width of an eyelid, 1.3; interorbital interval, 2.7; arm, 15; hand, 7; leg, 37; tibia, 12.2; foot and tarsus, 16.2.

Remarks: This species is seemingly most closely related to *Cochranella valerioi* but differs in having less webbing on feet and hands, a snout that does not have nostrils extend in advance of the lip, a wider interorbital distance, the thigh pigmented above and a somewhat larger tympanum.

The specimen was taken at night on a leafy plant growing out from the bank and over a small rivulet. The call is a low whistle.

Cochranella colymbiphyllum (Taylor)

Figure 36

Centrolenella colymbiphyllum Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 262-263 (type locality, American Cinchona Plantation [Isla Bonita] Caribbean drainage of Volcán Poás, Costa Rica; R. C. Taylor and E. H. Taylor colls.).

Cochranella colymbiphyllum Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 34.

Diagnosis: Tympanum moderately distinct, its diameter, in diameter of eye, at least 2.5 times; width of an eyelid in narrowest interorbital width, 1.25 times; frontal region shallowly concave, the areas about nostrils strongly swollen with a depression between; canthus indistinct, concave; skin below anal opening forming vertical folds extending under median part of thighs; tibiotarsal articulation to tip of snout or beyond snout; terminal disks of hand wider than digits; fingers less than one-half webbed; choanae large, the diameter of one contained in distance between them slightly less than two times; no trace of a humeral process; no free pollex rudiment; vomerine teeth absent.

Description of type: (K.U.M.N.H. No. 23812.) Adult male; vocal sac forms ample folds on chin and throat; head a little broader than body; eyes prominent, directed forward; rounded outline of jaw seen from above interrupted by snout which extends a little farther forward than edge of mouth; interorbital width small, about one fourth greater than width of an eyelid, slightly greater than distance between eye and nostril; frontal region slightly concave; the canthus rostralis indistinct, strongly concave; lores oblique, not or but very slightly concave; nostril distinctly nearer median edge

of lip than eye; a distinct depression between the swollen areas of nostrils; eyeball purplish black, the color showing through eyelids so they appear dark; lower part of tympanum distinct, largely directed upward but apparently covered with thin slightly pigmented skin, the inner edge more heavily covered.

Tongue subcircular, more or less emarginate on posterior edge, free only for about one sixth of its length; openings to vocal sac elongate slits extending along sides of tongue and somewhat be-



FIG. 36. *Cochranella colymbiphyllum* Taylor. Type K. U. M. N. H. No. 23812; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 26 mm.

hind; choanae very large, their diameter slightly more than half distance between them; vomerine teeth absent.

Upper part of arm very slender, forearm thickened with a strong fold on its outer edge, without a thin flap indicated at elbow; median palmar tubercle very distinct; inner tubercle rather indistinct, lacking nuptial rugosities but with the minute glandules visible under the skin; toes broad, terminal discs distinctly wider than digits, the width of outer finger disk equal to half eye diameter; outer fingers little more than one-third webbed; a trace of web between first two fingers. Leg elongate, the tibiotarsal articulation reaching 2 mm. beyond tip of snout; heels barely touch when

legs are folded at right angles to the body; a flat rather large inner metatarsal tubercle; outer tubercle if present very indistinct; toes nearly three-fourths webbed except that first two have webs extending scarcely half their length.

Skin not granular, but under lens some very minute elevations visible, each with a medial depression suggesting a crater; chin and throat smooth; abdomen areolate; a very small areolate area on under surface of thigh; skin below anus forming vertical folds, noticeable when femurs are at right angles to body.

Color: In life, uniform bright yellow-green on back and sides, with dim suggestions of cream flecks; on ventral surfaces whitish, semitransparent; tips of toes yellowish. In preservative (formalin transferred to alcohol), nearly white with numerous star-shaped chromatophores and indications of small rounded areas without pigment; under surfaces flesh-white without pigment; a very narrow line of chromatophores on dorsal surface of thigh.

Measurements in mm.: Snout to vent, 26; head length, 7.8; arm, 18; leg, 46.

Variation: The two paratypes taken at the same time and place differ negligibly, save that the tympanum is a little smaller and a little less distinct, and the tibiotarsal articulation reaches only to the tip of the snout. The measurement variations are given in the following table:

*Measurements in mm. type and paratype of Cochranella colymbiphyllum (Taylor) **

No.	Total length	Head length	Head width	Arm	Hand and fingers	Leg	Foot and tarsus	Tibia	Femur
23812	26	7.8	9.5	18	8	43	20	15	13.7
790	25.8	8	9.2	18	8	43	18.8	13	12.8
791	25	7.4	9	16.5	7.7	44	19	13.8	13.5

There is a vague possibility that *C. colymbiphyllum* is identical with Boulenger's *Hylella puncticrus* that has been synonymized with *Centrolene prosoblepon* by Nieden (1923).

Remarks: *Cochranella albomaculata* differs from this form in having the snout less protruding, the hand more than half webbed, the feet four-fifths webbed, the vomerine teeth present, and the nostril closer to the eye. The dorsal color is lavender dotted with numerous cream spots. The eyelid is purplish black.

Cochranella granulosa differs in having the dorsum strongly granular, the nostrils closer to the eye than middle edge of lip,

* This corrects an error in the original table of measurements. The numbers 23812 and 791 were originally interchanged inadvertently.

the snout sloping obliquely in front of the nostrils, the vomerine teeth present and the choanae much farther apart. The webbing on hand and foot is distinctly greater.

Cochranella valerioi differs in having a very small tympanum the interorbital space twice width of an eyelid and the nostrils slightly anterior to lip.

C. fleischmanni differs in having the eyelid golden, the under surface of the thigh very strongly areolate on the entire under surface, a distinct outer metatarsal tubercle present, choanae farther apart, and the frontal area not concave. Both species have the vomerine teeth absent and the degree of webbing about the same.

The presence of vomerine teeth, numerous white punctations below the eye and the granulation of the underside of the thigh distinguishes *C. pulverata*.

The specimens were collected at night from leaves of plants growing in a small mountain stream. They appeared to be very wary and numerous individuals dived into the water and escaped. In the same identical habitat a series of *Centrolene prosoblepon* were taken. These were apparently less wary and more easily captured.

Cochranella pulverata (Peters)

Hyla pulverata Peters, Monatsb. Akad. Wiss. Berlin, 1873, p. 614 (type locality "Chiriqui" H. Ribbe, coll.); Brocchi, Etude des Batracien de l'Amérique Centrale; Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 1, 1881, p. 41; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 386; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, p. 280.

Centrolene pulveratum Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 1931, pp. 393, 399 (part.) (Turrialba and Bebedero, Costa Rica); *ibid.*, vol. 8, June 7, 1933, pp. 73-74.

Centrolenella pulveratum Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, April 20, 1949, p. 258.

Cochranella pulverata Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 35.

Diagnosis: A small species (24 mm.); vomerine teeth present; tympanum present, round, small, covered with pigmented skin; back smooth, belly and under thighs granular; first and second fingers equally long, both shorter than fourth; strong web between second and third, and third and fourth fingers; toes fully webbed. Small white punctations above, with minute pigment spots or chromatophores.

Description of species: (data from the type description.)—Vomerine teeth in two groups between the choanae, which are much larger than the small openings of the Eustachian tubes. Tongue scarcely emarginate behind. Snout, not longer than the eye, with a rounded canthus rostralis. Tympanum round, very small, and

covered over with pigmented skin. Back smooth, the belly and underside of thigh granular; first and second fingers apparently equally long, much shorter than the fourth; first finger entirely free; the web between the second and third fingers reaches almost to the terminal pads of the second and somewhat over the base of the first joint of the second; between the third and fourth from the terminal disc of the fourth to the middle of the penultimate phalanx of the third. The toes are bound with a complete web which leaves only the two outer joints of the fourth toe free.

Color: Colorless, with scattered small white punctations which are numerous on the side of the head. Under a lens the surface is seen to be punctate with dark flecks.

Measurements in mm.: Total length, 24; head, 9; head width, 8; arm, 15; hand, with third finger, 8; leg, 45; foot and fourth toe, 20.

Remarks: One specimen, the type, is known from Chiriquí, Panamá. The species has been reported by Dunn from Bebedero and Turrialba, Costa Rica. The material not being available, I have not been able to confirm these identifications.

Cochranella granulosa (Taylor)

Figure 37

Centrolenella granulosa Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 265-267 (type locality Los Diamantes, 1 mile south of Guápiles, Costa Rica. R. C. Taylor coll.).

Cochranella granulosa Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 34.

Diagnosis: A rather large species of the genus (28 mm.) with strongly granular skin on head, back and sides of body, dorsal part of limbs, venter and undersurface of thighs. Toes $\frac{3}{4}$ to $\frac{1}{2}$ webbed; vomerine teeth present; no projecting rudiment of a pollex; tibio-tarsal articulation to 2 mm. beyond tip of snout; nostrils equidistant from eye and median tip of snout; eyelid purple, body (alcohol) creamy white with numerous scattered purple or lavender spots. Tympanum present; first finger equal to second in length.

Description of type: Head broader than body, the eyes strongly protruding, directed somewhat forward, the pupil horizontal; canthus rostralis distinct, slightly rounded; area about nostrils somewhat elevated with a slight depression between them; in front of nostril, snout slopes forward and down obliquely to edge of lip; loreal region sloping more gradually to lip; interorbital distance about one to one and one-half times width of eyelid; tympanum present, its diameter practically three times in longitudinal diameter of eye; a supratympanic fold from eye to near insertion of arm.

Tongue cordiform, slightly notched behind; opening to vocal sacs

curved slits reaching from level of middle of tongue to considerable distance behind tongue; choanae large, circular, the diameter of one contained in distance between them four times; two very indistinct vomerine ridges between choanae, each bearing two or three vomerine teeth.

Fingers short and broad, the tips dilated, that of fourth finger one half diameter of eye; a mere trace of web between first and second fingers; about one-fourth to one-fifth webbed between second and third but a rather distinct fringe reaches to terminal pad on outer

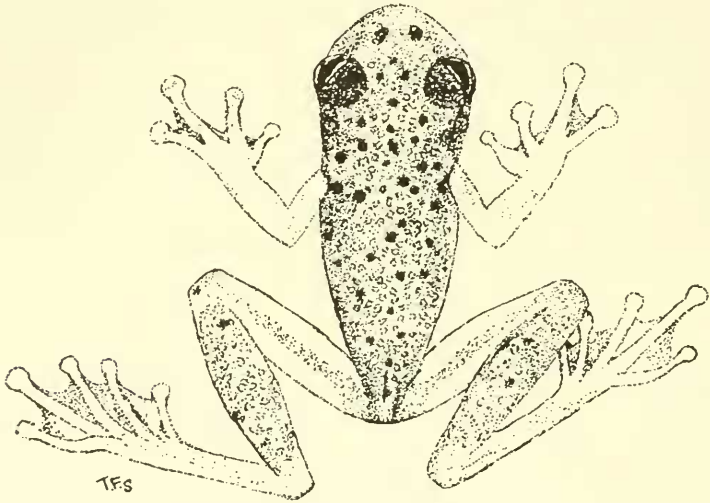


FIG. 37. *Cochranella granulosa* (Taylor). Type. Richard C. Taylor, no. 2463; Los Diamantes, Costa Rica. Actual snout-to-vent length, 28.2 mm.

side of the second; between third and fourth a little more than two-thirds webbed, a fringe reaching terminal pad on outer side of third finger; subarticular tubercles well defined; a large, very distinct oval palmar tubercle; large tubercle at base of first finger bearing colorless nuptial asperities, which extend much beyond tubercle and across the dorsal surface; a strongly defined fold on underside of forearm.

Legs long, the heels overlapping little more than two millimeters; tibiotarsal articulation extends beyond tip of snout about two or three millimeters; toes three-fourths to four-fifths webbed; subarticular tubercles distinct, rather large; a strong inner metatarsal tubercle; and a very small outer; a very slight, scarcely distinguishable inner tarsal fold.

Granulations on skin strongly defined on back, sides, head, and to a lesser extent on surface of forearm and lower part of leg and foot; on throat and chin, skin rugose but apparently not granular; venter and the greater part of underside of thigh, strongly areolar or granular, the granules being very much larger than those on back; those under the thigh distinctly larger than those on venter; a narrow, but relatively long transverse free flap covers anal opening. Large vocal sac, its surface somewhat rugose; nuptial asperities on thumb.

Color: In life, leaf-green with some slightly darker areas evident; below transparent white or flesh; in preservative (formalin transferred to alcohol) color cream-flesh with a very faint wash of lavender and with numerous (about 40) small purple spots; under a lens the lavender wash is seen to be caused by very numerous, small chromatophores. All ventral surfaces, and much of the lateral surfaces of limbs and body, cream-white, lacking pigment; eyelids purple; eyes silver with some purplish reticulation.

Measurements in mm.: Snout to vent, 28.2; width of head, 10; axilla to groin, 16; arm, 18; leg, 49.

Variation: The paratype is somewhat more lavender than the type. The dorsal spots are smaller and more numerous on the back and on the tibia. The iris of the eye is darker; the vomerine tooth patches are more distinct. Otherwise the two agree in all essential details.

Remarks: The absence of a humeral hook or process places this species in the genus *Cochranella* Taylor. Noble regarded the absence of vomerine teeth a character of the genus *Centrolenella*. However the teeth are not invariably present. The teeth may be absent in some individuals of a species and present in others.

The position of the nostril, halfway between eye and the median tip of snout, the purple eyelid, the very granular skin, the longer leg, presence of a tympanum, absence of a pollex rudiment, and the markings, will together distinguish this form from other species of *Cochranella*.

The specimens were taken at night during a rain on small trees growing on the edge of a small river.

Cochranella albomaculata (Taylor)

Figure 38

Centrolenella albomaculata Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949 (type locality Los Diamantes, one mile south of Guápiles, Costa Rica. E. H. Taylor and R. C. Taylor colls.).

Cochranella albomaculata Taylor, Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, p. 35.

Diagnosis: A rather large-sized species of the genus (27 mm. snout-to-vent); tympanum distinct, nostrils slightly closer to eye than to median point of snout at tip; interorbital distance equal to width of eyelid; heels overlapping; tibiotarsal articulation 4-5 mm. beyond tip of snout; toes five-sixths webbed, the membrane touching the terminal expansions on one side or other of all toes, save fourth; a distinct web present at base of first and second fingers; posterior part of back slightly but indistinctly granular; vomerine teeth strongly developed in two ridges near posterior level of



FIG. 38. *Cochranella albomaculata* (Taylor). Type K.U.M. N.H. No. 23814; Los Diamantes, Costa Rica; actual snout-to-vent length, 26 mm.

choanae. No pollex rudiment; purplish lavender with numerous cream spots on all unconcealed dorsal surfaces; first finger longer than second.

Description of type: Head a little wider than body, the eyes large, protruding, their diameter equal to their distance from tip of snout; areas about nostrils strongly swollen, with a depression between and somewhat behind them; canthus rostralis wanting; in front of nostrils the snout slopes to the edge of lip at an angle distinctly greater than slope of loreal region; lores distinctly concave; tympanum small, its greatest diameter contained in distance from

eye one and three-fourths times, and in the longitudinal diameter of eye a little more than three times.

Tongue rather rounded, not or but very slightly emarginate posteriorly, free for about one fifth its length; openings of vocal sacs elongate, curved slits, lying partly at side of tongue and extending some distance behind; choanae large, their diameter contained in space between, about three times; vomerine teeth in two raised patches lying between the posterior level of choanae and extending somewhat behind this level; (in paratype not reaching posterior level of choanae).

Digits short, widened at the tips, that of third finger a little more than one half diameter of eye; a very narrow web between first two fingers; second and third fingers one-third webbed, the web extending as a fringe to the terminal expansion on outer side of second finger; third and fourth toes two-thirds webbed, the web extending beyond level of subarticular tubercles; latter strongly developed; an elongate pad at base of first finger and very distinct palmar pad at base of wrist; base of first finger with an area of nuptial asperities; supernumerary tubercles indistinct; upper arm slender, forearm thickened with a well-developed fold on under side; legs long and slender, the tibiotarsal articulation extending several millimeters beyond tip of snout; when leg is adpressed to body heels overlap 2.2 mm.; toes four-fifths webbed, the web reaching the terminal pad of each toe on one side, except fourth; terminal pads truncate, that of inner toe rather pointed; a rather large inner metatarsal tubercle, rounded anteriorly, the tip slightly free; outer, if present, very indistinct; subarticular tubercles well developed; some distinct supernumerary tubercles; inner tarsal fold scarcely indicated.

Skin with some indistinct granulation on posterior part of back; slightly rugose anteriorly and on sides of body; upper surface of limbs also slightly rugose; throat and breast smooth; abdomen granular as is the greater part of under side of thigh; an enlarged granule on each thigh medially; segmentation of abdominal muscles distinctly indicated on venter; a small free flap over anal opening.

Color in life: Yellow-green on all exposed surfaces, with indications of small cream dots; all concealed surfaces creamy white, nearly transparent; in preservative (formalin transferred to alcohol) purplish to dark lavender above, somewhat lighter on the upper surface of limbs with numerous rounded cream spots or punctations, somewhat larger on hind limb than on back; venter and under

surface of limbs cream white; eyelids dark purple with white flecks; iris purple with minute silver flecks; some white flecks in tympanic and anal regions.

Measurements in mm.: Snout to vent, 26; width of head, 9; arm, 19; length of hind limb, 50; axilla to groin, 14.

Variation: The single paratype collected in the same locality with the type agrees in all essential details save that the vomerine teeth are somewhat farther forward; and an outer metatarsal tubercle is indicated. The color has been somewhat changed due to rust in the preserving fluid.

FAMILY HYLIDAE Günther

Hylidae Günther, Catalogue of the Batrachia Salientia in the collection of the British Museum, 1858 (1859), p. 96.

For the most part, the widely distributed family of the Hylidae comprises frogs adapted to arboreal habitats, although certain genera may contain species that are wholly terrestrial in habit. Most of the hylid species have the terminal parts of their digits widened, the underside of which bears an adhesive pad or disc that enables the animal to cling to smooth surfaces in a vertical or even in an inverted position. In some forms the inner finger may be partly or wholly opposed to the other digits. In a few forms the skin on the head is co-ossified with the skull and a casquelike cranium may be developed.

Eggs of the hylidae may be deposited in fresh water, on the ground, on leaves above the water, in arboreal bromelias—plants that accumulate water in the leaf axils—or they may be carried about by a parent in a dorsal brood-pouch.

The six hylid genera here recognized in Costa Rica are: *Anotheca*, *Smilisca*, *Acrodytes*, *Phyllomedusa*, *Agalychnis* and *Hyla*—the latter composite. The species here treated as *Hyla albomarginata* probably does not belong in the genus *Hyla* in a restricted sense, since it has a well-developed pollical spine present in males; and the group including *Hyla fimbrimembra*, *Hyla richardi* and *Hyla immensa* are probably not generically identical with *Hyla*. Just what the generic relationship is, in these forms, cannot be decided at the present because of lack of necessary skeletal material from South and Central America.

The genus *Hyla* is the largest amphibian genus, in point of species, in the Costa Rican fauna. It is significant, that in one Central American group of the genus, five species have been described from single specimens and to date, presumably, no others have been

found. In other groups of the genus *Hyla* one or more species are likewise known from one or at most very few specimens.

In collections made in 1947 by Richard C. Taylor and myself were six presumably undescribed species; in the 1951 collection there are at least four others regarded as new. Of the six new species taken in 1947 only one was represented in the collection taken in 1951.

It is difficult to account for the fact that of the Hylidae alone ten endemic species are known in Costa Rica from single specimens; while several others are known from single collections of from two to five specimens each. When the entire salientian fauna is considered, this number of unique types is greatly increased. Because of the general inaccessibility of the forms adapted to arboreal conditions, *Hyla* probably has the greatest number of undiscovered species. Several arboreal frog voices, quite unknown to me, were heard in various parts of the country, suggesting species that still await discovery. These facts and others bespeak a very inadequate survey of the salientian faunas of Costa Rica and the remaining Central American territory; and much more collecting must be done before an adequate treatise on the Central American Salientia can be written.

Since the 1947 and 1951 collections were made from the middle of June to the middle of September, sampling of the faunas during other months of the year is essential to our knowledge. This present work on the hylids must of necessity be considered of a preliminary nature.

KEY TO COSTA RICAN GENERA OF THE FAMILY HYLIDAE

1. Adults with a series of sharp spines bordering edges of bones in interorbital and occipital region of skull *Anotheca*
 Adults lacking series of spines on head bones 2
2. Skull with an elongate bony process or spine from frontals, extending somewhat behind orbit, not visible externally; a pair of vocal sacs on sides of chin in males *Smilisca* °
 Skulls lacking such a process 3
3. A pair of vocal sacs in males extending out on sides of head behind jaw angle. A parotoid gland (often diffuse) on occiput and dorsum *Acrodytes*
 Vocal sac when present single and confined to chin 4
4. Pupils of eyes horizontal *Hyla*
 Pupils of eyes vertical 5
5. Feet with an ample web; vomerine teeth present *Agalychnis*
 Feet without webbing; vomerine teeth absent *Phyllomedusa*

° The presence of the bony process can be determined by superficial dissection.

The following North- and Central American genera are recognized in the Family Hylidae.

<i>Hyla</i>	<i>Diaglana</i>
<i>Acris</i>	<i>Triprion</i>
<i>Pseudacris</i>	<i>Corythomantis</i>
<i>Acrodytes</i>	<i>Pterohyla</i>
<i>Smilisca</i>	<i>Plectrohyla</i>
<i>Anotheca</i>	? <i>Nyctimantis</i>
<i>Nototrema</i>	<i>Ptychohyla</i>
<i>Agalychnis</i>	<i>Hylella</i>
<i>Phyllomedusa</i>	

Miranda-Ribeiro* has recognized several other genera in South America including:

<i>Güntheria</i>	<i>Fritzia</i>
<i>Trachycephalus</i>	<i>Coelonatus</i>
<i>Carbeana</i>	<i>Flectonotus</i>
<i>Aparasphenodon</i>	<i>Gastrotheca</i>
<i>Hylomantis</i>	<i>Opisthodelphis</i>
<i>Bradymedusa</i>	

Not having studied this material, I have no first-hand knowledge of the merit of these genera but suspect that many of them, possibly all, merit generic distinction. I doubt that representatives of these occur in Costa Rica. It is likewise probable that certain other generic names proposed by older authors, merit resurrection from synonymy.

Genus SMILISCA Cope

Type of genus: *Hyla baudinii* Duméril and Bibron.

Frogs of this genus are distinguished by paired vocal sacs and a postorbital spine on skull. A single widespread species is recognized.

Smilisca baudinii (Duméril and Bibron)

Hyla baudinii Duméril and Bibron, *Erpétologie Générale*, vol. 8, 1841, pp. 564-565 (type locality Córdoba, Veracruz—restricted); Noble, *Bull. Amer. Mus. Nat. Hist.*, vol. 38, 1918, pp. 241-242 (localities in Nicaragua); Schmidt, *Zool. Ser. Field Mus. Nat. Hist.*, vol. 22, no. 8 (publ. 512), Dec. 30, 1941, p. 486 (localities in British Honduras); Schmidt and Stuart, *ibid.*, vol. 24, no. 21, Aug. 30, 1941, p. 238 (San Gerónimo, Guatemala).
Smilisca baudinii Cope, *Proc. Acad. Nat. Sci. Philadelphia*, vol. 17, 1865, p. 194.

The species is included on the basis of two Costa Rican specimens from Nicoya, Guanacaste.

* Miranda-Ribeiro, *Notos Para Servirem as Estudo dos Gynnobatrachios (Anura) Brasileiros*. *Arch. Mus. Nac. Rio de Janeiro*, vol. 27, 1926, pp. 63-114.

Diagnosis: Rather large hylid frogs, characterized by a pair of sharp pronglike processes on the sides of the frontoparietal bone; males with paired ventral vocal sacs; diameter of tympanum approximately three fourths of eye length; digital discs smaller than tympanum; a tarsal fold present; inner metatarsal tubercle compressed elevated.

Description of species: (From a specimen from Apatzingan, Michoacán, Mexico.) Head in preserved specimens tending to bend down at something less than a right angle to the body; the interorbital region slightly concave; area about nostrils slightly swollen without a depression between; snout rounding in profile, extending slightly beyond mouth; canthus distinct curving forward; lores concave and sloping obliquely to lip; tympanum overhung by a fold from eye that curves down a short distance, then continues back an indefinite distance above arm as a loose skinfold; diameter of tympanum (4.6 mm. in greatest diameter) about four fifths of eye length (5.7 mm.); distance between tympanum and eye less than half diameter of tympanum; length of eye a little less than axial length of snout (6.1 mm.); vomerine fasciculi high, closely approximated, transverse, the tooth rows between middle of choanae; separated from large choanae by a little more than length of one fasciculus; palatal glands opening in sinuous groove, nearer anterior end of palate than to choanae; tongue subcircular to broadly cordiform, with a suggestion of posterior emargination; males with vocal slits, and paired sacs visible on underside of chin and throat; a breast fold indicated; openings of Eustachian tubes smaller than choanae.

Arm rather long, the digits with discs much smaller than tympanum; inner finger somewhat opposed to other fingers, shorter than second, the two with only a slight lateral ridge representing web remnant; outer fingers one-fifth to one-fourth webbed with slight fringes to discs; a large inner metacarpal tubercle; palmar tubercle rather large, bi- or tripartite; palm granular with some supernumerary tubercles; subarticular tubercle single except one on outer finger that may be slightly bifid; a ridge or series of tubercles on outer edge of forearm.

Leg moderately long, the heel reaching to front edge of eye; inner metatarsal tubercle large, compressed with a narrow, free, protruding edge; outer tubercle very diminutive; toes three-fourths webbed; a strongly compressed tarsal fold.

Skin generally smooth but under a lens minutely corrugated and

pustulate, the pustules slightly larger on sides of dorsum; chin and breast granular, the granules not as distinct or so closely approximated as on venter and median part of ventral surface of thighs.

Vent opening at upper level of thighs followed by a distinct groove bordered by two narrow vertical folds or slight ridges; an indefinite ridge between nostril and eye across loreal region.

Color: (in preservative.) Dark blackish brown above, almost obscuring some large irregular blackish spots; a distinct bar across eye and a dark spot below eye; lip with a very narrow cream border; tympanum lavender brown; a dark spot or stripe from tympanum to above arm not too well defined; sides grayish with some light marks in groin; chin and breast white, venter and under part of limbs flesh white; limbs dimly barred with gray reticulation on back of thigh.

Measurements in mm.: Snout to vent, 62; width of head, 22; length of head, 18; diameter of tympanum, 4.6; length of eye, 5.7; length of snout, 6.1; arm, 35; hand, 16; leg, 85; tibia, 30; foot and tarsus, 41.

Variation: Specimens vary considerably in color. During the breeding season the two sexes may be deep leaf-green to olive green above, with a light orange or creamy yellow venter; there are spots in the groin that are cream or light orange yellow.

Specimens taken at other times are more rarely green but are darker, usually a shade of brown with black spots or markings on back, and dark cross-bands on limbs. There is almost invariably a dark stripe crossing the tympanum, extending back above arm insertion. The tympanum is usually uniform brown or lavender-brown.

Remarks: The voice of the males is a loud "quack, quack" and in the breeding season they develop deafening choruses. They are frequently heard at other times where a group of males are congregated in trees especially on rainy or misty evenings.

This species has been confused with two other Costa Rican species: *Hyla phacota* and *Hyla gabbii*. Both of these are differentiated by the absence of the spines on the frontoparietal and the males have a single vocal sac. *Hyla gabbii* presumably never has the black temporal stripe behind tympanum; but it is present in *Hyla phacota*. This latter species is larger, with longer hind legs reaching at least to the tip of the snout or farther. Females of the three species are sometimes more difficult to separate and on occasion I have had to resort to a dissection (cutting skin on head

to determine the presence or absence of spines on the frontoparietal*) in order to be sure.

Genus ANOTHECA Smith

Type of genus: *Gastrotheca coronata* Stejneger.

The adults of this species may readily be identified by the thorny spines around the back of the head in both males and females. These are not evident in young specimens.

The type of this species was collected at Palomo, Valle de Orosi, Cartago, Costa Rica. The species has not been rediscovered in Costa Rica, and is still known only from the type, unless a small specimen taken by C. E. Underwood in Costa Rica before 1900, and reported by Günther as *Nototrema oviferum* Lichtenstein and Weinland, is indeed this species. The species has been taken in numbers in Veracruz. That the range is continuous from Veracruz to Costa Rica may be questioned, since in the very numerous collections made during the past forty years in northern Central America and Southern Mexico no specimen of this conspicuous form has appeared.

Anothea coronata (Stejneger)

Figure 39

? *Opisthodelphys ovifera* Günther, Catalogue of the Batrachia Salientia in the collection of the British Museum 1858 (1859), p. 117 (Córdoba, Veracruz, Mexico) (*nec Notodelphys ovifera* Lichtenstein and Weinland).

Nototrema oviferum (part.)? Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, p. 288, pl. 74, fig. a (Carillo, Costa Rica) (*nec ovifera* Lichtenstein and Weinland); Nieden, Das Tierreich, Lief. 46, Anura I, June, 1923, p. 324.

Gastrotheca coronata Stejneger, Proc. U. S. Nat. Mus., vol. 41, Aug. 14, 1911, pp. 287-288 (type locality, Paloma, Valle de Orosi, Cartago, Costa Rica, 1200 M. elev. C. Picado, coll. U.S.N.M. No. 48270); Kellogg, U. S. Nat. Mus. Bull. 160, 1932, pp. 131, 133-135; Picado, Bull. Sci. France Belg., ser. 7, vol. 5, 1913, pl. —, fig.; Dunn, Copeia No. 3, Nov. 19, 1937, p. 164. "The type . . . still the only Central American specimen of the genus."

Anothea coronata Smith, Proc. Biol. Soc. Washington, vol. 52, 1939, pp. 190-191, pl. 1, figs. 1-3, pl. 2, fig. 6; Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, pp. 601-602, figs. 60 B-C (Mexican localities Cuautlapan, Córdoba and San Juan de Gracia).

Diagnosis: Much of the skin on top of head grown solidly to underlying bone in adults; outline of the parietal region somewhat concave, the edge of the skull with a bordering row of high, conical, erect, bony spines, only the tips of which are visible or they may be entirely covered by the thickened glandular skin; spines present also above tympanum, and a supraorbital series also present; tympanum circular nearly as large as eye; fingers free; toes one-third webbed.

* Cope. Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, pt. 1, July, 1866, pp. 85-86, pl. 25, gives a figure showing skull characters of this species.



FIG. 39. *Anotheca coronata* (Stejneger). K.U.M.N.H. No. 27365; 13 km. WNW Potrero, Veracruz, Mexico, 1700 ft.; actual snout-to-vent length, 46 mm.

Description of the species: Head nearly as wide as long, the skin tending to form pustular glandules about the spines; elsewhere skin tending to fuse with the bone; canthus rostralis somewhat elevated with granules representing small concealed spines; snout rounded, slightly longer than the length of the orbit; top of head and loreal region concave; eyelid much narrower than interorbital space; tympanum circular, its diameter about four fifths of the length of orbit; nostrils closer to median edge of upper lip than eye; width of an eyelid 2.45 mm., interorbital width 5 mm.

Tongue subcircular, slightly emarginate behind, less than one-sixth free behind; choanae large; vomerine teeth in two closely approximated, elevated fascicles between choanae but reaching behind their hinder level; palatal glands open into a transverse sinuous groove on palate anterior to choanae; maxillary teeth in specimen 45 mm., in length 35-37; premaxillary teeth 9-9; arm moderately long without an axillary web; fingers somewhat flattened without web but with small lateral ridges on fringes; subarticular tubercles large, those on outer fingers double as is that under second finger; prominent elevated supernumerary tubercles on palms; a large meta-

carpal tubercle at base of first finger and a tripartite outer palmar tubercle (these may be distinct or in contact); a few indistinct tubercles under arm; leg of medium length the heel reaching midway between eye and nostril; toes about a third webbed; however, that between two inner toes vestigial (one fifth), on outer toes one third to two fifths. The fifth toe reaches beyond distal tubercle of the fourth toe; a distinct tarsal fold present; discs on fingers, the largest equal to three fifths of the tympanum; skin smooth to partly granular above; the bony surface of skull very rough, granular; chin and breast smooth; belly closely and finely granular; median half of underside of femora granular; anal opening low with a long flap, the opening almost on a level with the ventral surface of body.

Measurements in mm. of type: Snout to vent, 60; snout tip to tympanum, 21; tip of snout to posterior edge of "casque" on median line, 18; width of head, 22; arm and foot (from axilla), 41; hind leg from vent, 93; tibia, 31.

Color: In alcohol, dark bluish slate; on sides and in groin several large, vertical, dark spots narrowly edged with whitish; hind limbs with transverse bands of dark color similarly edged with whitish; below paler.

Variation: Mexican specimens are often gray or lavender gray above. The side of head is purplish with a large gray spot on lores. The femora have purplish spots on the posterior and anterior faces that may meet on the dorsal surface; the underside of the tibia and tarsus has intense purplish black spots outlined in whitish cream; the chin and throat are usually brown, the venter purple. There are two areas on the breast outlined in white.

This species, in Costa Rica, is known only from the type specimen and perhaps one other specimen. Dr. Hobart M. Smith found the species to be common under the drying petioles of standing banana plants in central southern Veracruz at certain seasons. The figure given is of a specimen from 13 kilometers west-northwest of Potrero, Veracruz, Mexico.

Genus ACRODYTES Fitzinger

Types of genus: *Phrynohyas* (*Acrodytes*) *venulosa* = ? *Rana venulosa* Laurenti.

There is some uncertainty as to the proper (oldest) generic name available for this group. *Phrynohyas* may have to take precedence. Cope* however refused *Phrynohyas* in favor of *Acrodytes*. I cannot decide the matter at this time.

* Cope, Natural History Review, 1865. p. 109.

Only a single species of the genus is known to occur in Costa Rica and it is not wholly certain that it is conspecific with *Rana venulosa* of Laurenti as I have treated it here.

Acrodytes venulosa (Laurenti)

Rana venulosa Laurenti, Specimen medicum, exhibens synopsis reptilium emendatum cum experimentis . . ., 1768, p. 31 (*part.*).
Phrynohyas (Acrodytes) venulosa Fitzinger, Systema reptilium, vol. 1, 1843, p. 30.
Acrodytes venulosa Taylor, Univ. Kansas Sci. Bull., vol. 30, pl. 1, May 15, 1944, p. 64.

Until the South and Central American forms of this genus are reviewed the reference of the Costa Rican form of *Acrodytes* to this species is a matter of guess.

Diagnosis: Large tree frogs; skin thick, leathery, strongly glandular; a pair of lateral vocal sacs in the males usually to be found just above the arm; hind legs short, the heel reaching to tympanum; toes four-fifths webbed; a small web remnant between the fingers; no trace of a tarsal fold present.

Description of species: (U.M.M.Z. No. 71211, Los Huecas, C. R.). Head thick, the width (27 mm.) greater than the length (23 mm.); length of the eye (6.5 mm.) equal to its distance from nostril; diameter of tympanum (5 mm.) less than eye length, separated from eye by a distance of 3 mm.; no canthus rostralis indicated; area about nostrils not swollen; loreal region sloping obliquely to lip; tip of snout sloping obliquely to near edge of lip, the tip extending 2 mm. beyond the edge of lip; width of an eyelid (6.8 mm.) about equal to interorbital distance; distance between nostrils 5 mm.; length of eye nearly equal to length of snout.

Vomerine teeth in two enlarged fasciculi situated between the choanae, almost contiguous mesially; choanae diagonally elongate, smaller than a single fasciculus, the teeth forming two irregular curving series; the palatal groove forming a sinuous line that reaches to very near the anterior edge of palate; vocal slits rather short; tongue about as broad as long, free behind for only about one sixth of its length; dorsum with a single broad "parotoid" varying in thickness from 1.2 mm. to .5 mm. Scattered over this area are some larger glandules that appear on the surface as scattered granulations but appear smooth and rounded on the skin surface; thin black vocal sacs appear in a fold above arm insertion; the supratympanic fold not distinguishable from the edge of the parotoid area, that tends to overhang the tympanum.

Arm short, thick, the wrist reaching at least to tip of snout; discs on fingers enlarged, the largest equaling the tympanum in extent; a strong web remnant between three outer fingers, of lesser extent between the two inner; first finger somewhat opposed to other three, the web forming a slight fringe or ridge to the pads on all digits; distal subarticular tubercles all well developed, that of outer finger bifid; inner metacarpal tubercle elongate oval; outer and medial tubercles small, scarcely indicated; leg moderate, the heel reaching tympanum; tarsus smooth without fold, but with a faint raised area along outer edge; inner metatarsal tubercle oval, small, 3.5 mm. long, less than half length of first toe (8.5 mm.); toes four-fifths webbed, the web reaching discs on outer side of first, second and third, and inner side of fifth; a fringe or ridge reaching discs elsewhere; subarticular tubercles strong; supernumerary tubercles scarcely indicated; outer metatarsal tubercle flat, scarcely discernible; limbs and arms smooth as is back, save for a few scattered, smooth, granulelike elevations; chin, breast, venter, much of ventral and posterior part of thighs, granular.

Color: Purplish above with indication of fine lighter lines, the lines tending to break up the dark area into asymmetrical, elongate stripes; a dorsolateral light lavender stripe from eyelid back to middle, that widens and turns down towards venter. A purplish area surrounding tympanum extends back above arm; a yellow area about arm insertion; legs and arms barred with purple, the spots light-edged; venter nearly uniform yellow-cream.

Measurements in mm.: Snout to vent, 77; head width, 27; head length, 23; length of eye, 6.5; eye to nostril, 6.53; diameter of tympanum, 5; snout length, 6.8; arm, 38; hand, 21; leg, 96; tibia, 33.5; foot and tarsus, 48.

Remarks: We did not find this form in Costa Rica, and I have used a University of Michigan specimen from Los Huecas, C. R., for the description.

Genus AGALYCHNIS Cope

Type of genus: *Hyla moreletii* A. Duméril.

These frogs are strictly arboreal in habit. Certain of the species of the genus lay their eggs above the water on the leaves of plants or on the edge of a pool. The color in life is usually green above and saffron or orange below. Three species are recognized in Costa Rica.

These may be identified by the following key:

KEY TO COSTA RICAN SPECIES OF AGALYCHNIS

1. A series of diagonal cream lines on side of body, eye red; smaller, less than 60 mm. 2
No diagonal cream lines on sides of body, larger, 75 mm. . . . *moreletii*
2. A dark purplish lateral band bordered above by cream and interrupted by at least five narrow vertical cream or yellow bands; 32 mm. ♂ *helenae*
Dark lateral band not bordered by a cream line but broken by several vertical bands; under surfaces saffron; 34.5 mm. ♂, 45 mm. ♀ *callidryas*

Agalychnis moreletii (A. Duméril)

Figure 40

- Hyla moreletii* A. Duméril, Ann. Sci. Nat. Paris, ser. 3, Zool., vol. 19, 1853, p. 169 (type locality, Cobán, Verapaz, Guatemala); Keferstein, Nachr. königl. Ges. Wiss. Göttingen, 1867, pp. 256, 257; and Arch. für Naturg., 34th Jahrg. Heft. 1, 1868, p. 297 (Costa Rica); Brocchi, Bull. Soc. Philom. ser. 7, vol. 1, p. 122; Mission Scientifique au Mexique (etc.); Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 31, pl. 13, fig. 1.
- Agalychnis moreletii* Cope, Nat. Hist. Rev., 1860, p. 110; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 107 (San José, Costa Rica); Boulenger, Catalogue of the Batrachia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, pp. 422-423; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 15; Werner, Abh. Akad. Wiss., Bd. 22, Abt. 2, 1903, pp. 351-352 (Cobán, Guatemala); Verh. zool.-bot. Ges. Wien, 1896 (p. 9 in separate), (Honduras); Gage, Carnegie Inst. Washington Publ. no. 457, 1936, p. 293 (Campeche); Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, pp. 599-601, pl. 31; Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, pp. 71-72.
- Phyllomedusa moreletii* Kellogg, U. S. Nat. Mus. Bull., no. 160, 1932, pp. 142, 143, 146-147, figs. 19a, 20a, b (hand and foot); (Mexico and Guatemala).
- Hyla holochlora* Salvin, Proc. Zool. Soc. London, 1860 (1861), pp. 460-461, pl. 32, fig. 2 (Cobán, Guatemala).

Diagnosis: A large frog, brilliant green and orange or green and cream in life, which may become bluish (or perhaps more often lavender or purplish) and flesh white in preservative; upper arm extremely thin with a much thickened forearm; pupil vertical; finger discs large, with fingers more than half webbed; tongue about half free; vent opens on a level with lower surface of thigh.

Description of species: (From K.U.M.N.H. No. 29549, Cartago, Costa Rica.) Rather large, the snout-to-vent length reaching 55 mm. in males, 75 mm. in females; width of head (17.7 mm.) very slightly less than length (18 mm.); canthus distinct, rounded; area above nostrils very little swollen without distinct depression; from nostrils snout slopes obliquely forward to lip; loreal region slightly concave, the upper part nearly vertical, the lower sloping obliquely to lip; supratympanic fold diagonal, overhanging and covering upper part of tympanum; latter very distinct, subcircular, its length 3.2 mm., separated from eye by distance equal to half its diameter;

eye prominent, its length (5.3 mm.) greater than its distance from nostril (5. mm.) but shorter than length of snout (8 mm.); nostril minutely nearer the median notch in upper lip than eye; width of an eyelid (4.6 mm.) much less than interorbital width (7 mm.); choanae rather large, irregular, the distance between them 5.2 mm.; diameter of a choana in this distance 3.4 times; vomerine teeth in two small fasciculi between anterior part of choanae, separated from each other and from choanae by a distance equal to length



FIG. 40. *Agalychnis moreletii* (A. Duméril). K.U.M.N.H. No. 29549; Cartago, Costa Rica; actual snout-to-vent length, 54 mm.

of a fasciculus; tongue subcordiform, notched posteriorly and anteriorly, free behind for a third of its length; vocal slits rather short having a distinctly posterior position in mouth; openings of palatal glands in a sinuous row, not forming a groove, and nearer to the median anterior point of palate than to choanae.

Skin generally smooth, but under a lens is seen to be minutely corrugated or granular; supratympanic fold diagonal, overhanging slightly; a strong skin fold from elbow to disc of outer finger; a less well-developed one on leg from heel to disc of outer toe; venter strongly granular; breast slightly granular, the chin less so; granules

extending high on sides of body; anal flap elongate, the vent opening on a level with ventral surface of thigh; slight pads under outer part of the anal flap, its surface covered largely with strong granules; under surface of thigh covered with irregular granules.

Arm long, the anterior half of forearm reaches beyond snout; upper arm thin, less than half diameter of forearm; finger discs large, the three outer of nearly same size; first about half diameter of fourth; subarticular tubercles large, that on outer finger single but with a slight indentation; inner metacarpal tubercle large, its dorsal surface and that of base of first toe with nuptial swelling covered with minute horny asperities; between fingers one and two, one-third webbed, between two and three, web is two thirds length of second finger; between third and fourth, web reaches level of distal subarticular tubercles; palmar tubercle divided with median portion the larger; supernumerary tubercles present on palm.

Leg short, reaching anterior edge of eye; when legs are folded at right angles to body, heels barely touch; discs on toes smaller than those on fingers; between first and second toes one-third webbed; between others about two thirds webbed; inner tarsal fold thick, distinct, numerous distinct supernumerary tubercles on sole and toes.

Color: Above uniform green, on body, head and upper surface of unconcealed portions of limbs; venter and all concealed surfaces yellowish. In preservatives the dorsal color becomes purplish lavender, the yellow changing to flesh white; some whitish flecks about anal region (white spots rarely present on back).

Measurements in mm.: Snout to vent, 54; width of head, 17.7; length of head, 18; length of tympanum, 3.2; length of eye, 5.3; length of snout, 8; arm, 38; hand, 18; leg, 78; tibia, 27; foot and tarsus, 38.

Remarks: In a population occurring in the environs of Cartago, Costa Rica, I found some variation in males as to the length of fingers and the amount of webbing. None however approach the degree of webbing depicted in Nieden's figure, *loc. cit.*

The upper arm is entirely without the green coloration and the upper part of thigh has a narrow band of green usually the entire length of femur.

Specimens were taken on rainy or misty nights. Males were heard calling and their calls traced. Females are not represented.

It seems most probable that *Agalychnis holochlora* and *moreletii* are conspecific. I have no topotypic material from Coban, Guatemala, the type locality, available for comparison with the Costa Rican forms referred to *moreletii* here. When compared with a

Mexican specimen, the Cartago specimens have somewhat smaller pads and seemingly are smaller and a little more slender. However only a single Mexican specimen is at hand for comparison.

Agalychnis helenae Cope

Agalychnis helenae Cope, Proc. Amer. Philos. Soc., vol. 22, 1884 (1885), pp. 182-183 (type locality, Nicaragua, J. F. Moser, coll.); Proc. Amer. Philos. Soc., vol. 23, 1886, p. 274; Peracca, Boll. Mus. Torino, vol. 11, 1896, No. 253, p. 12; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 290 (Mexico, Teapa, Tabasco; Nicaragua, Hda. Rosa de Jericho, 3250 ft.; Costa Rica, San Carlos; Panamá, Darién, Río Sabaná); Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, pp. 343-344, pl. 16, fig. 2 (photograph of a specimen).

Diagnosis: A rather small member of the genus with a somewhat indistinct tympanum; fingers one-fourth webbed, toes one-third webbed; eye one third longer than snout; nostrils nearly terminal; a dark purplish lateral stripe broken by vertical yellow bars; eye red or orange-red.

Description of species: (Data from the type description.) Head large and wide, snout short; long diameter of eye a little less than length of snout in front of eye, measured obliquely; or one third longer than snout measured axially; length of eye in the width between anterior canthi of eyes, one and one-half times; nostril nearly terminal; canthus rostralis distinct, concave; tympanum a subvertical oval, not distinct, two thirds as long as the diameter of eye; lower eyelid with oblique subparallel white veins; vomerine teeth in short series directed inwards and backwards from anterior inner angle of choanae; tongue large, wide, openly emarginate behind; inner digits of hand not opposable, all digits bearing discs, the first and second shorter than adjoining digits; fingers one-fourth webbed, toes one-third webbed; heel reaches tip of snout. Skin smooth, heel and elbow with a dermal thickening at the apex; inside of elbow joint is slightly webbed.

Color: The color in alcohol is greenish cream. The same color covers the external faces of forearm, tibia, tarsus, fifth toe and a narrow band on upper face of femur. The humerus and concealed surfaces of limbs orange; a well-defined dark purplish band bordered above by a yellow line, extends from axilla to groin. The dark lateral stripe interrupted by five vertical narrow yellow bands which cross the purple lateral band and join the yellow border. Digits and lower surfaces yellowish; deeper yellow on abdomen.

Measurements in mm.: Snout to vent, 30; width of head, 11.5; arm, 10.8; leg, 42; foot and tarsus, 17.5.

Remarks: Cope (1886) reported a Nicaraguan specimen, larger

than the type, in which a yellow line borders the lateral purple stripe and the bars which cross it are wider. There are also traces of pale cross bands on the back. Noble, *loc. cit.*, describes the life coloration of a specimen from Colorado Bar, Costa Rica, which was kept alive for some time. Generally the ground tone was a dark slaty green or a bright leaf-green. A number of pale green spots would often appear, scattered irregularly over the back; sometimes they would form an H-shaped mark just anterior to the pectoral girdle; concealed portions of the legs, which appear purplish in alcohol, were a deep blue in life. The feet and hands were brilliant orange. The edge of the upper eyelid was a deep yellow in striking contrast to the orange-red iris. The ventral surface of the throat and body was yellowish white; anterior appendages slaty color, while the posterior limbs were a yellowish white washed entirely, except for a narrow strip, with the deep blue of the concealed portions. Noble states that it is called "la rana de los plátanos."

Description of K.U.M.N.H. No. 30412 ♂: Snout-to-vent length, 32 mm.; head narrowed anteriorly; canthus distinct, very slightly rounded, curving slightly from eye to nostril; nostrils not terminal, the snout in front of nostrils slopes forward to tip; eyes prominent, blood-red in life, the pupil vertical (in preservation all trace of red lost and the pupil appears nearly round); tympanum more or less distinct, covered with skin, showing fine granulation; distance between tympanum and eye about one half diameter of tympanum (3 mm.); length of eye (7 mm.) slightly greater than length of snout (6.4 mm.); width of an eyelid (4.3 mm.) less than inter-orbital distance (5 mm.).

Tongue oval, deeply notched behind, free behind for more than a fourth of its length; vocal slits extending some distance behind tongue; choanae large, irregular, somewhat angular, their outer edges partially concealed by the palatal shelf; vomerine teeth in two fasciculi situated between choanae, and converging until they are separated by less than half length of one fasciculus, separated from choanae by a distance about that of a single fasciculus; opening of Eustachian tubes large but definitely smaller than choanae.

Arm elongate, the upper arm very slender, more than two thirds of the forearm reaching beyond tip of snout; discs on toes larger than tympanum; base of first finger with a small patch of dark nuptial excrescences, extending on the surface of the large inner metacarpal tubercle; a small web remnant between first and second fingers; that between second and third fingers equal to a little less than half length of second toe; web between two outer fingers

reaching half the length of outer finger; distal subarticular tubercles elevated, single, but outer ones may be indented on anterior edge; supernumerary tubercles present; a ridge or fold from wrist to and onto elbow; outer metacarpal tubercle if present not distinguishable from other tubercles.

Leg moderate, rather slender, the tibiotarsal articulation reaching about halfway between eye and nostril; terminal discs on toes small, scarcely wider than digits; webbing between first and second and between second and third, about half length of inner digits; two-thirds webbed between outer toes; a distinct inner metatarsal tubercle, no small outer tubercle; a tarsal fold moderately prominent, becoming higher near and on heel.

Skin smooth, seen under a lens very finely granular on dorsum; skin on sides finely striate or wrinkled; an indistinct fold above tympanum continues down to above arm insertion; chin smooth; venter and most of under surface of thighs with fine granules; anal flap carried to ventral level of thigh.

Color in life: Brilliant green above; sides of body with a broad blue stripe from axilla to groin, bordered above by a creamy yellow line, and segmented by rather narrow yellow lines; light parts of hands and feet orange; darker parts green; chin dirty white; venter cream; lavender to blue on back of thigh, upper front of tarsus, and tibia; a narrow green line on upper surface of thigh; upper part of arm bluish; eye blood- to orange-red with a black vertically oval pupil; a yellow border on posterior edge of eyelid; lines in lower eyelid grayish or silver.

In preservation the green becomes purple, the blue becomes lavender; the yellow or orange areas become white.

Measurements in mm.: Snout to vent, 32; width of head, 17.7; length of head, 18; length of eye, 7; length of snout, 6.4; arm, 34; leg, 81; tibia, 27.5; foot and tarsus, 34.

Remarks: Individuals were found at Bataan, Costa Rica, at night (July 22), in a tree close to edge of a small rain-pool. They were discovered by tracing their calls. A third specimen was seen but it escaped by leaping to higher branches in a forest tree.

Agalychnis callidryas (Cope)

Hyla callidryas Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 14, 1862, p. 359 footnote (type locality, ° Panamá, Capt. Field, coll.).

Agalychnis callidryas Cope, Nat. Hist. Rev., 1865, p. 110; U. S. Nat. Mus. Bull. 32, 1887, p. 15 (near Córdoba, Veracruz; Panamá); Barbour, Bull. Comp. Zool. Harvard Coll., vol. 69, 1929, p. 145 (Corn Islands off mainland

° Smith and Taylor, (Univ. Kansas Sci. Bull., vol. 33, pt. 2, 1950, p. 347) inadvertently give Córdoba, Veracruz as the type locality. This should be Panamá.

of Nicaragua; San Pablo, República de Panamá); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, p. 414 (Barro Colorado Island, Canal Zone); Gaige, Carnegie Inst. Washington, Publ., No. 457, 1936, p. 292; Schmidt, Zool. Ser. Field Mus. Nat. Hist., vol. 22, 1941, p. 487 (Valentin, British Honduras); Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, p. 72 (Mexican localities); Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, No. 69, June 12, 1948, p. 35 (Alta Verapaz, Guatemala).

Phyllomedusa helenae Kellogg (*nec* Cope), U. S. Nat. Mus. Bull. 160, 1932, pp. 142, 145 (Mexican localities).

Diagnosis: In life, green with vertical pupil, the eye red; outer fingers one-fourth webbed; moderately large discs on fingers and toes; inner toes with a web remnant; three outer toes slightly less than one-half, to one-half webbed; straight rounded canthus rostralis; eyes moderate, shorter than snout; vomerine fasciculi arising near the inner pointed portion of large choanae, which are partially concealed when seen from below by elevated anterior border.

Description of species: (From the type description.) Head elongate, maxillary outlines convergent, nearly straight; loreal region subvertical. Canthus rostralis straight, rounded. Eyes not large, transparent portion of inferior palpebra reticulated with white; iris cupreous. Tympanum nearly as large as eye, obliquely elliptic. Tongue elongate elliptic, openly emarginate. Inner nares large, widely separate; vomerine teeth between these, in two oblique series convergent posteriorly, anteriorly opposite anterior border of nares. Fingers one-fourth webbed; discs very large; toes one-half webbed, margined; skin smooth above.

Color: Blue purple above, greenish on the scapular region; humerus, femur, except a narrow blue stripe, and under surfaces, uniform saffron. Numerous oblique bands of a lighter yellow on sides.

Measurements in mm.: Snout to vent, 34.5; snout to angle of mouth, 14.8.

Remarks: I have examined no specimen from southern Central America. It is included in the faunal list because the range presumably includes localities both north and south of Costa Rica.

A series of specimens from Tierra Colorado, Veracruz have the following characteristics (I am not wholly certain that the form is conspecific with the Panamá species): In these the tympanum is distinctly smaller than eye (3 mm. to 5.5 mm.), its diameter averaging approximately three fifths of eye length. Upper surface finely corrugated with extremely fine granulation on posterior part of back, on forearm and tibia; chin, breast, venter and most of under side of thighs with fine granules and with much larger granules on the outer edge of venter and along the posterior part of

the ventral surface of thigh; vent opening on level of ventral surface of thigh; strongly elevated subarticular and supernumerary tubercles on hand and foot; outer subarticular tubercle on fourth finger double; a very large inner metacarpal tubercle; palmar tubercle small conical scarcely distinguishable from supernumerary tubercles; elbows strongly flexed and protuberant. The eye (red in life) in preserved specimens becomes grayish white; the lateral band is purplish to lavender with two to five diagonal cream lines; there is no longitudinal yellow or cream line on side. A direct comparison of the population from Panamá may show other differences.

GENUS PHYLLOMEDUSA Wagler

Type of genus: *Rana bicolor* Boddaert.

Only a single species of this genus is known in Costa Rica. It may be readily distinguished from the species of *Agalychnis* by the absence of webbing on the foot, and absence of vomerine teeth. A vertical pupil is present.

Phyllomedusa lemur Boulenger

Figure 41

Phyllomedusa lemur Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 425 (type locality, Costa Rica).

Agalychnis lemur Cope, U. S. Nat. Mus. Bull. No. 32, 1887, p. 15; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, pp. 291-292 (Costa Rica); Nicden, Das Tierreich, Lief. 46, Anura I, June 1923, pp. 344-345.

Diagnosis: Slender frog having a narrow snout with subvertical sides; upper part of arms exceedingly slender without pigment; fingers and toes except outer, white above and below; a narrow line of pigment on upper surface of femur; tongue elongate, narrow, notched behind; vomerine teeth absent; anal flap elongated, notched; first toe shorter than second.

Description of species: (R. C. T. No. 772, Isla Bonita, C. R.) Head broader than body, its width at tympanum (9 mm.) a little less than its length (11.5 mm.); eyes strongly protuberant, directed somewhat forward, the pupils vertical; canthus rostralis rounding, the loreal region subvertical, sloping slightly to lip, the region between eye and nostril slightly concave; area about nostril somewhat swollen leaving the tip of the snout with a small emargination; tip of snout sharply truncate; distance from nostril to median notch in the upper lip (2.5 mm.) less than distance between eye and nostril (4.05 mm.); width of an upper eyelid (3.15 mm.) much less than interorbital distance (5.4 mm.); tympanum distinct, its diameter

(2.2 mm.) in eye length (4.5 mm.) approximately 2 times; length of eye equals distance of eye from nostril.

Tongue elongate, pointed anteriorly, somewhat widened and notched posteriorly, free for one fourth of its length; choanae large, lateral, not even partially concealed when seen from below; the vomerine teeth entirely absent; openings of palatal glands not discernible; 72 teeth in maxillary and premaxillary series; skin of dorsal and lateral surface of body smooth; on ventral surface

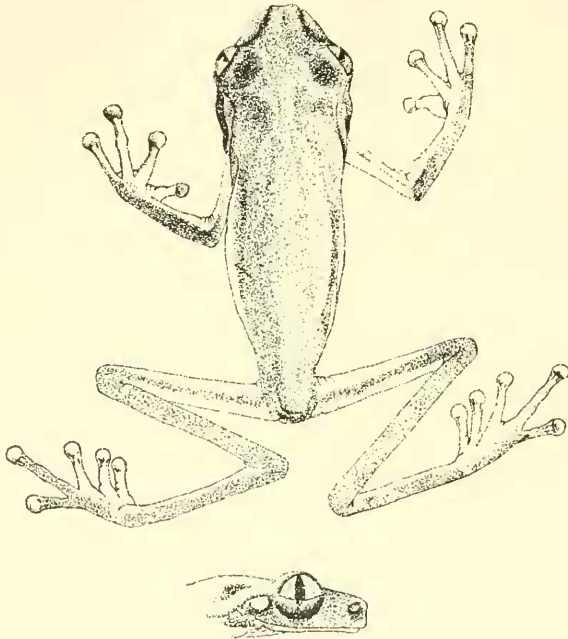


FIG. 41. *Phyllomedusa lemur* Boulenger. R. C. T. No. 772; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 44 mm.

abdomen strongly granular; indistinct granulation on under mesial portion of femurs; anal flap glandular, notched mesially, with some small glandular swellings on each side of anal opening.

Arms long, the upper arm slender, its smallest diameter 1.8 mm.; that of part below elbow 3 mm.; first finger shorter than second; second shorter than fourth; no trace of web; terminal discs widened, that of third finger (2.1 mm.), wider than tympanum; a prominent tubercle at base of first finger; two small palmar tubercles; distal subarticular tubercles large, none bifid; supernumerary tubercles on the palm and on bases of fingers; toes lacking webs; first toe slightly shorter than second; terminal pads a little smaller than those

on fingers; a moderately distinct inner metatarsal tubercle, a small rounded outer; numerous supernumerary tubercles on toes and soles; subarticular tubercles large.

Measurements in mm. of R. C. T. Nos. 613 and 772 respectively: Snout to vent, 33, 44; width of head at tympanum, 7.8, 9; length of head, 10.5, 11.5; arm, 21.5, 29; leg, 50, 65; tibia, 18, 23; tarsus and foot, 22, 29.

Color: (R. C. T. No. 772.) Above nearly uniform magenta-pink with minute greenish (cream in preservation) streaks or clouding discernible under a lens; outer and upper surface of forearm, tibia and tarsus magenta, with a narrow streak of magenta along the median upper surface of femur, extending on outer toe and finger; edge of upper lip white; venter, chin, and under side of limbs white; eye gray; concealed upper parts of toes, foot, and thighs canary-yellow.

This rare species was found on the northern slope of Volcán Poás by Richard Taylor, who obtained two specimens; one from a clump of shrubs, along a small stream at about 2500 feet elevation; a second larger specimen from bushes along a small rivulet at Isla Bonita (5500 ft.) at night. The specimen taken during the day was green above in life. That taken at night was purplish red. The color here recorded is that of the latter specimen.

Genus *HYLA* Laurenti

Type of the genus: *Hyla viridis* Laurenti.

The composite genus *Hyla* as here treated, is composed of several groups of frogs certain of which I believe merit generic distinction; others perhaps subgeneric designation. Most of the generic groups have already been named by previous authors. The external characters of many of these are known; but the internal, especially skeletal, anatomy is in many cases unknown, and until such a study can be made the limits of the various groups must be in doubt.

KEY TO COSTA RICAN SPECIES OF *HYLA*

- | | |
|---|----------------|
| 1. A scalloped fringe more or less distinct on outer edge of hand and arm, foot and tarsus; a distinct pollex more or less developed, with or without spine | 2 |
| No scalloped fringe on outer edge of hand and arm, foot and tarsus; a distinct pollex not developed (except in <i>albomarginata</i>) | 4 |
| 2. Outer fingers completely webbed; skin above and below covered with horn-capped granules or tubercles; skin of head involved in ossification of skull bones; strong spine on prepollex; ♂ 100 mm.; Costa Rica | <i>immensa</i> |
| Outer fingers not completely webbed | 3 |

3. Skin finely shagreened above, the tubercles and granules may be minutely horn-capped; ventral granules smooth; skin of head involved in skull ossification; outer fingers three-fourths webbed; prepollux distinct but no spine; lips above and below with blackish border; digital discs black above; ♀ 71 mm.; Costa Rica *richardi*
 Skin with scattered tubercles above, none with a horny tip; black color absent from tips of digits and from lips; a prepollux present lacking spine; ♀ 31 mm.; Costa Rica *fimbrimembra*
4. A pair of toothlike denticles on medial edge of lower jaw; tympanum more or less concealed; ♂ 32 mm.; ♀ 33 mm.; Costa Rica and Panamá *picadoi*
 None or only a single denticle on medial edge of lower jaw; tympanum variable 5
5. A discrete white or yellow stripe from axilla to groin; eye red in life; no dorsolateral light line 6
 No discrete white or yellow stripe from axilla to groin; eye not red in life; (a narrow dorsolateral line may be present in *cherrei*, *underwoodi* and *angustilineata*) 8
6. Finger discs larger than tympanum; diameter of tympanum one third of eye; only a vestige of web on hand; an inner tarsal fold present and a more or less distinct outer tarsal fold; body usually dark brown; ♂, 28 mm.; ♀, 34; Costa Rica . . . *rufiocularis*
 Finger discs smaller than tympanum 7
7. Diameter of tympanum one half length of eye; outer fingers one-fourth webbed; no distinct inner or outer tarsal fold; heel to eye; usually olive green in life, becoming reddish lavender in preservative; finger discs one half of tympanum; ♂, 36 mm.; Costa Rica *alleei*
 Diameter of tympanum more than half length of eye; digital discs smaller than tympanum; outer fingers two-fifths webbed, toes four-fifths webbed; a moderately distinct inner tarsal fold, no outer; heel to front of eye; green becoming bluish or bluish lavender in preservative; 40 mm.; Costa Rica and Panamá *uranochroa*
8. When leg is laid forward along body, the tibiotarsal joint (heel) reaches tip of snout or beyond tip of snout 9
 When leg is laid forward along body, the heel fails to reach beyond nostril 15
9. Smaller forms; heel not or rarely reaching beyond tip of snout; tarsal fold may or may not be present 11
 Larger forms; heel in adults extending one or more millimeters beyond tip of snout; a strong tarsal fold 10
10. A black stripe from eye through tympanum and beyond; tympanum five eighths length of eye; discs one half as large as tampanum; markings may or may not be present on back; ♂ 60 mm.; ♀ 73 mm.; Mexico to South America *phaeota*
 No black stripe from eye to tympanum; tympanum about one half length of eye; finger discs approximately as large as tympanum; fingers two thirds, toes fully webbed; ♂ 50 mm.; ♀ 75 mm.; Guatemala? to Costa Rica and Panamá *gabii*

11. Toes fully webbed; "diameter of tympanum one half area of eye;" fasciculi of vomerine teeth small, between middle of choanae; fingers with web vestige; canthus rostralis angular; 25 mm.; Costa Rica *cherrei*
 Toes not fully webbed 12
12. Fingers one-half webbed; webbing of toes and size of discs variable 13
 Fingers without or with only web vestige; outer toes one-third to two-fifths webbed; outer finger discs equal area of tympanum; a light dorsolateral line usually present; ♂, 30 mm.; Costa Rica *angustilineata*
13. Tympanum one half eye; toes four-fifths webbed; limbs and feet blackish; 39 mm.; Costa Rica *nigripes*
 Tympanum one fourth eye 14
14. Brownish black above; sides and femora deep black; [reach of heel unknown]; 37 mm.; Pico Blanco, Costa Rica *moesta*
 Belly unspotted white; no inguinal or lateral spots; [reach of heel unknown]; 37 mm.; Pico Blanco, Costa Rica *monticola*
15. Web between first and second toes proportionally much reduced; canthus rostralis weak or absent; snout flat, low, distinctly longer than eye; fingers free or with only a vestige of a web; no tarsal fold present; some small pustules present in skin 16
 Web between first and second toes not reduced proportionally; other characters variable 18
16. Larger; very large choanae, at least five to six times the area of a vomerine tooth fasciculus; palmar tubercles strongly pronounced; outer metatarsal tubercle nearly equal to inner tubercle; finger discs about half area of tympanum; legs strongly barred; some small pustules on back; 45 mm.; Nicaragua to South America *boulengeri*
 Smaller; the choanae variable in size; outer metatarsal tubercle very small or absent; finger discs more than half of tympanum; legs not strongly barred 17
17. Vomerine tooth fasciculi about equal to choanae; finger discs larger than tympanum; palmar tubercles not prominent; outer metatarsal tubercle absent; heel to front of eye; green or yellow-green in life, with or without stripes on body; ♀ 35 mm.; Nicaragua to Panamá, perhaps to South America *elaechroa*
 Vomerine tooth fasciculi about half area of choanae; finger discs smaller than tympanum; outer metatarsal tubercle small but distinct; uniform olive, yellowish olive or brownish with or without a bar between the eyes and longitudinal stripes; ♀ 27 mm.; Mexico to Panamá *staufferi*
18. A distinct inner tarsal fold present 19
 Usually no distinct tarsal fold present (if present a strong pollical rudiment in females, bearing a spine in males) 22
19. Eyes large, strongly protuberant, distinctly longer than snout; skin strongly pustular on back; finger discs smaller than tympanum; outer fingers about one-third, outer toes three-fourths webbed; first, third and fourth fingers with double subarticular

- tubercles; tympanum one half eye length; ♂ 32 mm.; Costa Rica *moraviaensis*
- Eyes not especially large or strongly protuberant, not longer than snout; webbing and subarticular tubercles on digits variable.. 20
20. A very strong axillary web; skin above somewhat pustular; finger web vestigial, toes fully webbed; red or orange red color on front and back of thigh and in groin; yellow below; distal sub-articular tubercle single; ♀, ♂, 45 mm.; South Mexico to Costa Rica *loquax*
- Axillary web, if present, scarcely discernable..... 21
21. Most distal subarticular tubercles double; fingers one third or more webbed; skin not pustular or tubercular above; no orange or red coloration; ♂ 27; ♀ 32 mm.; South Mexico to Costa Rica (perhaps to and into South America)..... *embraccata*
- Fingers one-third or more webbed; toes two-thirds to three-eighths webbed; arms of males thickened; color variable, often with spots forming an hourglass-shaped figure, or olive gray with a dark lateral band from axilla to groin; ♀ 46 mm.; Costa Rica and Panamá *pseudopuma*
22. The underside, front and back of arm granular, like venter. Tympani more or less directed upward; a pair of strong tubercles or ridges below vent; ♀ 25 mm.; Costa Rica and Panamá. *zeteki*
- Arm not granular like venter; tympani directed laterally; no special tubercles or ridges below vent..... 23
23. A pollex present bearing spine; a narrow glandular lateral fold; 48 mm. *albomarginata*
- No pollex present, or pollical spine; no narrow glandular dorso-lateral fold 24
24. Snout narrowed, strongly projecting beyond lip; nostril much nearer the eye than median point on upper lip 25
- Snout not especially narrowed and not or scarcely projecting beyond lip 26
25. Tympanum less than half of eye length; finger discs larger than the tympanum; strong vestige of a web (less than one-fourth webbed) between outer fingers; a thickened ridge on outer edge of tarsus; first and third and fourth fingers usually with bifid subarticular tubercles; a strong canthus; dark spots or flecks on venter; ♀ 35 mm.; Costa Rica *rivularis*
- Tympanum one half of eye length; outer fingers one-half webbed; double tubercle under fourth finger usually; moderately sharp canthus rostralis; no outer tarsal fold; an elongate dorsolateral light spot; 26 mm.; Costa Rica *debilis*
26. Bright yellow in life with a cream line beginning behind eye and continuing onto shoulder; no distinct tarsal folds but a thick low elongate ridge may be discernible; a pair of diagonal skin folds from sides of vent diverging posteriorly; Costa Rica. *alvaradoi*
- Not bright yellow in life or white in preservative; no cream line behind eye 27

27. Strongly defined lateral black marks on sides and yellow spots on front and back of thigh; ♂ 26 mm.; ♀ 29 mm.; Pico Blanco, Costa Rica *pictipes*
 Not so colored 28
28. A small cream or yellow frog with a network of black on back; no dorsolateral darker stripe bordered by light above; ♀ 24 mm.; Central America *phlebodes*
 Not so colored 29
29. Small frog with a darker lateral stripe on head and body separated from dorsal color by a more or less definite lighter line. Dorsal coloring without reticulum of black or distinct darker spots. Costa Rica *underwoodi*
 Larger, without a lateral stripe; light brown with usually two irregular dorsal stripes joined at one point; tympanum two thirds of eye length; discs smaller than tympanum; fingers less than one-fourth or one-fifth webbed; outer toes two-thirds webbed; ♂ 44 mm.; Costa Rica *wellmanorum*

Hyla immensa sp. nov.

Figures 42, 43

Type: Kansas Univ. Mus. Nat. Hist. No. 30404; Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica, June 25, 1951; Edward H. Taylor, coll.

Diagnosis: A large frog (♂, approximately 100 mm. snout to vent); the skin of dorsal surface of head co-ossified with skull; skin everywhere covered with rounded or spiny tubercles capped with blackish horn; tympanum distinct, somewhat overhung by a supra-tympanic ridge; an irregular scalloped fringe on outer edge of foot, tarsus, and to a lesser extent on hand and arm; fingers and toes fully webbed except between first and second fingers; prepollex bearing a subarticular tubercle on its base, terminating in a heavy pointed spine at right angles to first finger; openings from mouth to vocal sacs almost completely behind tongue.

Description of type: Head large, its width (38 mm.) much greater than its length (30 mm.); eyes moderately prominent, the width of an eyelid (8 mm.) contained in the distance between eyelids approximately 1.8 times; canthus rostralis distinct, its edge slightly rounded and curving to nostril; snout short, truncate, nose-like, the swellings about nostrils prominent, terminal with a depression between them; mouth broadly rounded; upper part of loreal region nearly vertical, then sloping obliquely to edge of lip; tympanum large, sharply distinct, the edges elevated, its diameter (5.5 mm.) more than half of eye length (8.2 mm.); distance between eye and tympanum approximately equal to diameter of latter; a

strong, ossified, supratemporal ridge overhangs the tympanum and continues to a point behind it, its outer edge with tubercles.

Tongue broad, slightly notched behind, the anterior three fourths circular in outline, irregular posteriorly, no part of it free; vomerine tooth fasciculi lying between posterior part of choanae, nearly contiguous mesially, but separated from choanae by half the length

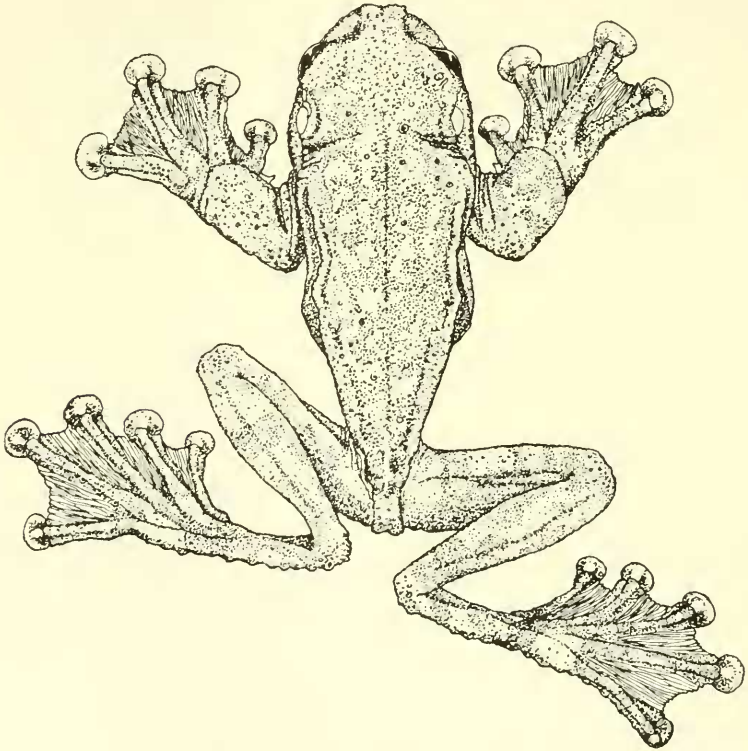


FIG. 42. *Hyla immensa* sp. nov. Type ♂. K.U.M.N.H. No. 30404; Turrialba, Costa Rica; snout-to-vent length, 100 mm.; dorsal view.

of a fasciculus; the teeth form a slightly curving line which lies just behind the posterior level of choanae; Eustachian tube openings smaller than choanae.

Arm greatly thickened and more or less fixed, being held close to body; fingers with transversely oval pads, their width being equal to or greater than their length; web between the two inner fingers equals half length of first finger; disc of first finger about half the area of that on second finger; three outer fingers webbed to base of discs, except outer side of second which has web attaching

to side of disc; prepollex with a strong, exposed spine placed at right angle to first finger; a well-developed subarticular tubercle at base of prepollex; subarticular tubercles under digits single; a few supernumerary tubercles moderately distinct; outer toe with a distinct fringe not continuous with a scalloped ridge on under surface of forearm.

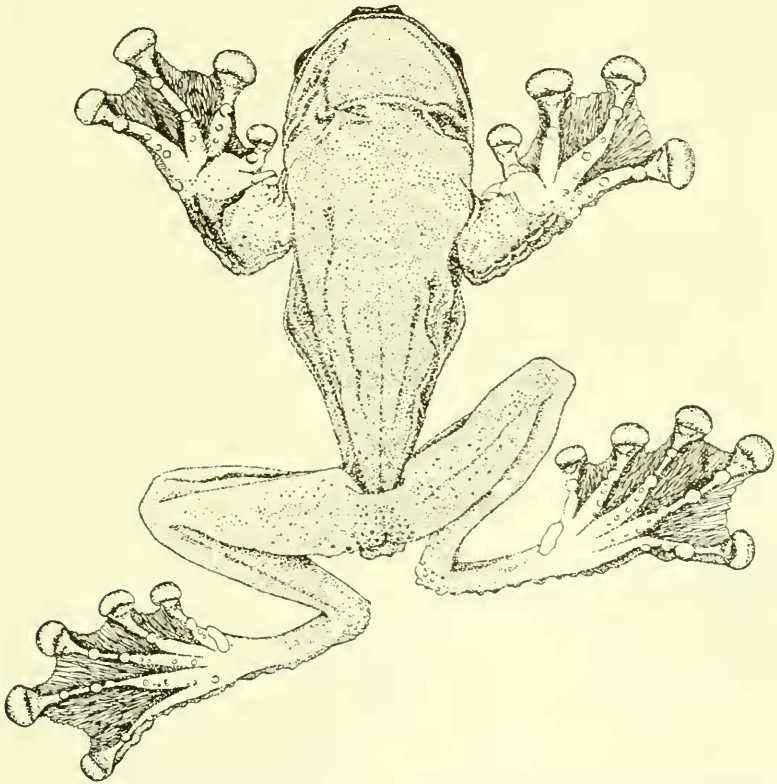


FIG. 43. *Hyla immensa* sp. nov. Type ♂. K.U.M.N.H. No. 30404; Turrialba, Costa Rica; snout-to-vent length, 100 mm.; ventral view.

Legs moderate, the tibiotarsal joint reaching to near middle of eye; digital pads distinctly larger than tympanum but smaller than those on fingers; toes fully webbed, the webs reaching on sides of discs; inner metatarsal tubercle moderately large, outer small, rounded; an irregular fringe on outer toe and along outer edge of tarsus; a well-defined inner tarsal fold extends from tubercle to heel; no outer fold; when legs are placed at right angles to body, the heels strongly overlap.

Skin everywhere on dorsal surfaces with tubercles varying much in size, all larger than those on venter; tubercles capped with dark brown or black horn; skin on under surfaces of chin, breast, belly and under thighs with minute tubercles all of which bear black, rough-surfaced, horny caps; under surface of hands and feet with none or but few horny tubercles.

Skin of head coalesced with skull bones; back flat, the skin on dorsum more or less completely joined to back; body angular with a suggestion of a dorsolateral fold on edge; a prominent lateral irregular skin fold from axilla not reaching groin; external folds of vocal sac evident but not ample; no transverse chest fold; anal opening on a small fleshy protuberance.

Color: Above lavender-brown, the legs somewhat lighter and indefinitely barred; discs of fingers blackish above, the webs darker than digits; sides brown with some black markings more or less light-edged; venter, chin, throat and concealed parts of limbs black or blackish brown with a few white irregular areas under arms and on breast, and smaller flecks of white under thighs, tibia and tarsi. The discs are not darker than remainder of digits.

Measurements in mm.: Snout to vent, 100; head width, 38; head length, 30; width of outer finger discs, 8; arm length (estimated), 70; leg, 157; tibia, 52; tarsus and foot, 74.

Relationships: The species belongs in the group of hyloid frogs that includes *Hyla miliaria*, *fimbrimembra*, *richardi*, and *phantasmagoria*, and probably is most closely related to the latter. It differs from the latter in the character of the tuberculation of the skin, the dorsal tubercles being larger than those on venter; the prepollex terminates in a sharp exposed spine instead of ending bluntly without a spine; the limbs are shorter, the heel reaching middle of eye rather than beyond snout. It is probable that numerous other differences exist but the type description of *phantasmagoria* omits most measurements and certain pertinent characters such as vocal slits, choanae, tongue, etc. The greatly thickened forearm, whose diameter is only a little less than the greatest diameter of the thigh, probably represents another difference. The discs on toes are differently shaped.

Remarks: The type specimen was obtained from mud at the bottom of a water-filled cavity in a tree, about five feet above the ground. I was prompted to investigate the cavity solely by curiosity since the specimen had not been seen. It is presumed that it had been perched near the surface of the water and on my approach had

submerged quietly. Once in Mindanao, P. I., in just such a cavity I had discovered *Hazelia spinosa*, a new genus and species of rhacophorid frogs.

Hyla richardi Taylor

Figure 44

Hyla richardi Taylor, Copeia, 1948, No. 4, Dec. 31, pp. 233-234, fig. 1 (type locality 2 mi. west Isla Bonita [American Cinchona Plantation] Caribbean slope, Volcán Poás, Costa Rica).

Diagnosis: A large hyla with the skin of head co-ossified with skull; tongue longer than broad, not or scarcely emarginate behind; snout not especially blunt, the canthus distinct; tympanum distinct;

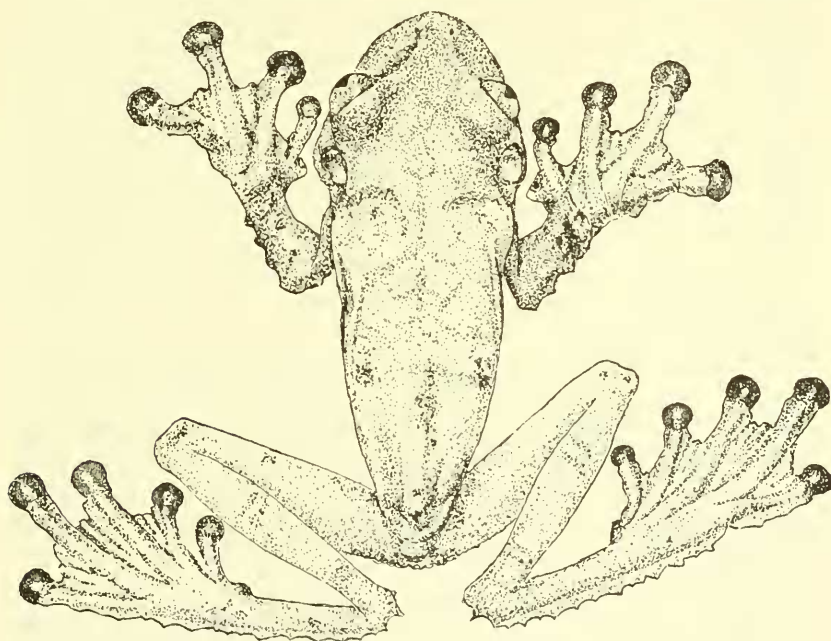


FIG. 44. *Hyla richardi* Taylor. Type. R.C.T. No. 761. Two mi. W Isla Bonita, Volcán Poás; actual snout-to-vent length, 71 mm.

outer fingers three-fourths webbed; toes about four-fifths webbed but reaching the disks only on one side of digits; a serrate fringe on outer side of limbs and outer digits; vomerine teeth between choanae; skin without warts or papillae but minutely shagreened, the minute pustules, visible only under a lens, capped with brown horn; a pollex rudiment but no spine evident in type (female).

Description of type: Length ♀ 71 mm., probably nearly fully grown; head a rather pointed oval, the front of the snout sloping

down to lip; canthus distinct, very slightly rounded; lores broadly sloping, distinctly concave; width of upper eyelid contained in the interorbital distance one and one-fourth times; tympanum distinct, directed slightly upward, its diameter contained in eye diameter one and one-half times; most of the skin of the dorsal surface of the head involved in cranial ossification; a pair of depressions behind skull giving a constricted appearance to head; a well-defined supratympanic fold curving over tympanum and extending back to shoulder; no median elevated area on occiput.

A pair of vomerine elevations bearing seven or eight teeth between choanae, separated from each other by a distance equal to their distance from choanae; palatal groove wanting, the palatal glands opening by an irregular series of small perforations; longitudinal diameter of choanae contained in the distance between them, three and one-half times; pupil horizontal, somewhat diamond-shaped.

Skin above finely shagreened, the tips of the minute pustules capped with brown horn, in some regions producing minute pointed spines (these visible only under magnification); a few indistinct tubercles on forearm; skin on chin nearly smooth; abdomen, as well as two thirds of ventral area of thigh, strongly and uniformly granular; a few granules below anus more or less fused on each side, separated by a median groove.

Arms short, upper arm especially short and slender; hands and feet not unusually large; the tibiotarsal articulation reaching to near anterior corner of eye; when leg is folded at right angles to body the heels overlap 4 to 5 mm.; arm with a serrate fringe from elbow to terminal disk of fourth finger; largest finger discs larger than tympanum, the discs wider than long; a well-defined, blunt, pollex rudiment without external evidence of a spine (may be present in male); first and second fingers with a rudimentary web (one fourth or less); outer fingers nearly three-fourths webbed; subarticular and supernumerary tubercles; palmar tubercle or pad much divided.

Legs moderately slender; a serrate fringe from tibiotarsal articulation to disc of fifth toe; discs on toes smaller than those on fingers, the web reaching or nearly reaching discs on outer side except on fourth toe where the membrane reaches the level of the distal subarticular tubercle; subarticular tubercles small under foot; numerous supernumerary tubercles on sole; inner metatarsal tubercle moderately large, the upper end somewhat free; a small indistinct rounded outer tubercle; heel with two or three conical tubercles.

Color: In life, nearly uniform lavender-brown with very indistinct darker markings; discs on all fingers and toes blue-black; edge

of lower jaw bluish black; a narrow line of black on edge of upper lip; throat yellow-brown with fine purple reticulation; venter and underside of thighs lavender-brown with cream marks; under side of hands and feet lavender; no light mark at vent.

In preservative, a faint trace of darker bars is evident on limbs, and there is some black pigment scattered on back; fringe on limbs colored like body.

Measurements in mm.: Snout to vent, 71; width of head, 28; length of head, 23; elbow to tip of longest finger, 37; femur, 32; tibia, 37; foot, 53.

Remarks: *Hyla richardi* differs from *H. fimbrimembra* and *H. miliaria* in having the derm of the head co-ossified with the skull; in lacking warty tubercles or lamellate papillae or tubercles; in having the surface of back, sides and head covered with minute pustules, many, perhaps most, of which are surmounted by minute horny spicules, visible only under a lens, but sensible to touch. The black coloration of the dorsal surface of the digital pads is characteristic. From *H. phantasmagoria* it differs in having much smaller feet and digital discs, and in lacking a casque.

Hyla fimbrimembra Taylor

Figure 45

Hyla fimbrimembra Taylor, Copeia, 1948, No. 4, Dec. 31, pp. 235-238, fig. 2 (type locality Isla Bonita, American Cinchona Plantation, Caribbean slope of Volcán Poás, Costa Rica, 5200 ft. elev.)

Diagnosis: Tongue broader than long, somewhat notched behind; tip of snout rounded, elevated, quadrangular, the canthus somewhat rounded; tympanum distinct; outer fingers one-half to two-thirds webbed; toes about three-fourths webbed; a strongly serrate fringe on side of outer finger and forearm, and on outer toe and outer side of tarsus to heel; skin of back and limbs tubercular; a pollex rudiment present, pointed and free at tip without spine (spine possibly present in male).

Description of type: Type ♀ 31 mm. long from tip of snout to vent, not full grown; front end of snout sharply truncate, the nostrils almost directly above edge of lip; area about nostrils swollen, the front edge of snout vertical; canthus rostralis rather rounded; nostril nearer median edge of lip than eye; loreal region sloping to lip, not or scarcely concave; smallest interorbital distance one and one-fourth times width of an eyelid; tympanum very distinct, directed somewhat upward, broader than high, its greatest diameter one and two-thirds times in greatest diameter of eye; a strong supratympanic fold arching up and over tympanum, and continuing to above arm

insertion (almost angular on left side); a transverse depressed area, bordering skull, behind and above tympanum, suggesting a constriction immediately behind head; a median elevated oval area from forehead to occiput, and a depressed area bordering eyelids; pupil horizontal, somewhat quadrangular; tongue one fifth broader than long, free for about one fifth of length, notched or emarginate behind; palate deflected downward from point behind level of choanae, the palatal groove distinct; two very distinct, rounded,

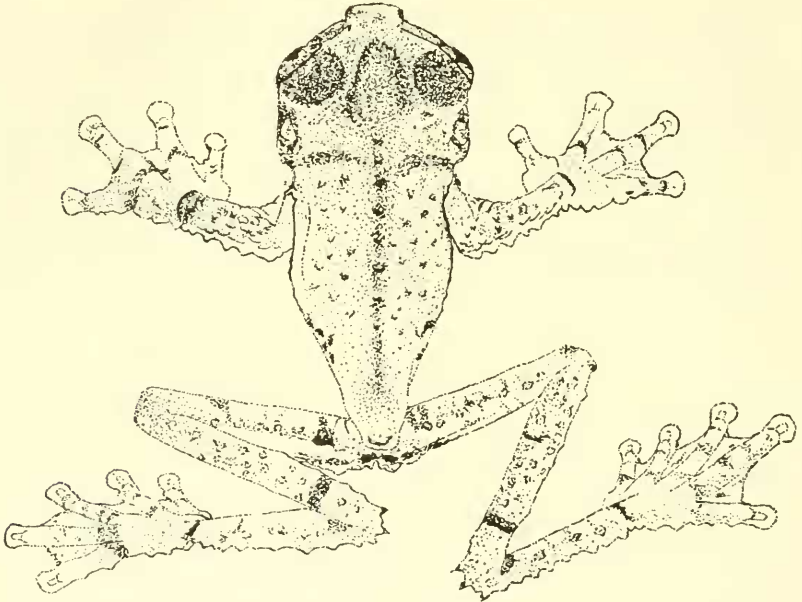


FIG. 45. *Hyla fimbriembra* Taylor. Type. R.C.T. No. 764. Isla Bonita, Volcán Poás; actual snout-to-vent length, 31 mm.

elevated areas between choanae, much closer to each other than to choanae, each about as large as a choana but each apparently lacking vomerine teeth (none can be seen or detected below surface by dissection; this may be a juvenile condition); choanae higher than wide, their longitudinal diameter in the distance between them about three times.

Upper arm rather weak; forearm heavy, with a strong, serrate fringe or fold on back edge of forearm and outer edge of fourth finger; inner finger with a distinct pollex rudiment, the tip free (condition of male unknown; may include spine); first finger much smaller than second; between first and second fingers about one-fifth

webbed, a slight fringe extending to terminal pad of first, and more than half length of second; second and third fingers a little more than half webbed, the web with a small smooth fringe reaching to near base of terminal discs; outer fingers two-thirds webbed, web extending beyond level of distal subarticular tubercles; distal subarticular tubercles well developed but rather small; numerous supernumerary tubercles; terminal discs of three outer fingers about equal to (or fourth, a little greater than), diameter of tympanum.

Leg moderate, tibiotarsal articulation reaching to nostril; half webbed between first and second toes; between four outer toes at least three-fourths webbed; diameter of largest terminal discs a little less than diameter of tympanum; subarticular tubercles small, distinct; a well-developed, terminally free, inner metatarsal tubercle; outer tubercle, if present, indistinct; many supernumerary tubercles; a very indistinct inner metatarsal fold; outer metatarsal fold developed into a conspicuous serrate skinfold or fringe extending length of tarsus and outer toe; heel with strong, pointed, soft tubercles; heels overlap about 3 mm. when legs are folded at right angles to body.

Skin on back and upper part of sides rather rough with scattered small warts or tubercles that are also present on eyelids, back of head, on exposed surfaces of limbs, and even on sides of head and snout where they are smaller; chin finely and rather indistinctly granular; belly with pavementlike granules; likewise granular under thighs; a thickened glandular fold, divided medially by a groove, below anal opening; from each end of fold a row of conspicuous granules ascend on either side, tending to curve above the vent; opening of vent near upper level of thigh.

Color in life: Brownish gray above, the extremities more ashen gray; chin and venter white with strong lavender reticulation on chin; on edge of underside of arm and tarsus a deep lavender stripe; elevated area on head blackish brown; limbs very faintly barred; some small brown flecks forming a short diagonal line on side; some flecks of brown in groin.

In preservative the dorsal color is somewhat lavender brown save that eyelids are dark and a slight median darker mark is evident behind occiput; a distinct blackish band present on wrist; a strong dark band on lower tarsus and one on proximal part of thigh; transverse bands evident on toes; metatarsal and metacarpal areas lighter; a grayish white spot below eye; yellow wash in groin and on part of anterior surface of thigh; around vent a pure white mark with two small black spots above, and with an indefinite darker

line running laterally for a short distance on back of thigh; tip of heel white; dorsal surface of discs cream.

Measurements in mm.: Snout to vent, 31; width of head, 12.5; length of head, 11; arm and hand, 18; leg, 52; foot and toe, 24.6; tibia, 17; femur, 15.6.

Remarks: The relationship of this species is with *Hyla miliaria* (Cope), a frog from Nicaragua, and with *Hyla richardi* described in this paper. The former is, I believe, known from only a single type specimen (U. S. National Museum No. 14193). I have recently carefully examined the type and compared *fimbrimembra* with it. *Hyla miliaria* has the three outer fingers and the toes completely webbed, while *fimbrimembra* has the outer fingers little more than half webbed, the toes four-fifths webbed. The skin of the head, the back and the limbs is covered with low, warty tubercles, while in *miliaria* the dorsum is covered with leaflike papillae or subspinous projections, most numerous on head above tympanum. The color of *miliaria* is dark plum or mulberry, with obscure coarse reticulations of a darker shade. The color on the ventral surface is yellow. The webs on the feet are plum-color except that yellow borders are present and the digits themselves are yellowish on the underside. The dermal processes are often light yellow in color. There are no black spots on the digital expansions. A white spot is present below the vent and the thigh is blackish behind. The tibia is dark.

The differences in color, in the amount of webbing between the toes, and the character of the skin distinctly separate the two forms *miliaria* and *fimbrimembra*. Numerous other differences are in evidence when the two descriptions are compared. Differences between *fimbrimembra* and *richardi* are discussed under that species.

The specimen was collected at night, clinging to a small plant bathed in the spray of a waterfall.

Hyla picadoi Dunn

Figure 46

Hyla picadoi Dunn, Copeia, 1937, no. 3, Nov. 19, p. 164 (type locality "a little above the farm of Manuel Acosta" 2140 m. Volcán Barba, Costa Rica. E. R. Dunn and Manuel Valerio, colls.).

Diagnosis: This medium-sized species (♂ 32 mm., ♀ 33 mm.) may be diagnosed by the following characters: tympanum covered with skin, concealed (or faintly visible); a glandular area evidenced by enlarged granules or pustules in the temporal region, continues back, below the supratemporal fold, to some distance on side; snout short with a small distinct "nose"; vomerine teeth be-

tween inner level of choanae, but behind choanae; front of lower jaw with two toothlike projections; arm granular on under side.

Description of species: (Univ. Mich. Mus. Zool. No. 70179, paratype.) Head broader than body, its width (10.4 mm.) greater than its length (9 mm.); canthus rostralis much rounded and curving from eye to nostril; area about nostrils slightly swollen, but no depression evident between them; upper loreal region somewhat concave, lower sloping obliquely to lip; length of eye (2.9 mm.)



FIG. 46. *Hyla picadoi* Dunn. Paratype. U.M.M.Z. No. 70179; 2140 m. Volcán Barba, Costa Rica; actual snout-to-vent length, 29 mm.

distinctly greater than length of snout (2.7 mm.); distance between nostrils (2.4 mm.) much less than distance of eye to nostril (3 mm.); a slight vertical ridge on the tip of snout not reaching lip, but seen from above has the appearance of a "nose"; snout extending .8 mm. beyond edge of lip; tympanic area and area immediately behind this covered with a soft granular skin obscuring the tympanum; a strong, discrete tympanic fold curves back over tympanic area to angle of jaw, with one or two enlarged tubercles in front of its terminus; width of an eyelid (2.8 mm.) much less than interorbital distance (3.9 mm.); nostrils terminal, equidistant between eye and the notch in upper lip; vomerine teeth in two somewhat rounded

fasciculi separated by about half the width of one fasciculus and from choanae by twice this distance.

Choanae smaller than fasciculi, separated from each other by a distance approximately 4.5 times width of a choana; no distinct groove on palate, the palatal glands seemingly opening by separate ducts; tongue thick, subquadrangular, wider behind than in front, wider than long, not or scarcely free behind. Arm moderate, the wrist reaching slightly beyond snout; terminal discs on hand 1.5 mm. wide; vestige of a web between the first two fingers; other fingers little more than one-fifth webbed, the palm strongly and uniformly granulate; inner metacarpal tubercle elongate, thickened, causing first finger to be very wide at base; fringes on fingers continuous with the edge of the discs; finger discs rather large, about half width of eye; distal subarticular tubercles of two outer fingers divided, those on inner fingers more or less bifid; palmar tubercle quadripartite, scarcely distinguishable from supernumerary tubercles; under side, front and back of arm strongly granulate like the venter.

Leg rather short, the heel reaching to middle of eye; legs folded at right angles, the heels overlap nearly 4 millimeters; web vestige between first two toes; between second and third, less than one third; between outer toes, about one-half webbed, the discs as large or only slightly smaller than discs on fingers; a prominent, much widened tarsal fold; inner metatarsal tubercle equal to one third length of first toe; outer tubercle smaller, distinct; sole of foot strongly granular.

Skin above on head and back smooth, shiny; temporal region and sides with large irregular granules, which tend to merge into the lateral and ventral granulation; no axillary web present; chin indistinctly granular; breast, belly, and underpart of thigh strongly granular; anal flap short, the skin above and below fluted; a small specialized gland in axilla formed by fusion of granules; area below vent with enlarged, but not otherwise distinctive, granules; the loose skin forms a thin fold along the side of the body (perhaps not a "permanent" character).

Color: Light brown above with a slightly darker area on occiput and an indefinite darker median line; an irregular dark brown dorso-lateral streak; tip of snout and loreal region darker; venter light without pigment as are the hands and feet; front and back of thigh uniformly but sparsely pigmented; on the tibia there is some marbling with darker brown. The swollen area behind eyes lighter than remainder of occiput.

Measurements of type and paratype^o in mm.: Snout to vent, 32, 29; width of head, 12, 10.4; length of head, 10.4, 9.6; interorbital width, 4.8, 3.9; eyelid, 2.5, 2.5; between nostrils, 2.2, 2; length of eye, 3, 2.9; length of snout, 2.8, 2.7; arm, 17, 18; hand, 9, 8; leg, 49, 43; tibia, 16.5, 14.8; foot and tarsus, 25.5, 22.

Remarks: The male type has elongated vocal slits and one fasciculus of the vomerine teeth seems to be missing. The palate is convex between the orbits. The palmar tubercle is bifid; the muscular areas behind the eyes are elevated somewhat, and an area on the top of the head is nearly flat. The granules in the axillary regions are quadrangular.

Specimens have been examined from El Gallito located on the east end of Volcán Barba, 1900 m. elevation. In these the eye is a little longer than the snout; the canthus is more distinct, and the nostril slightly closer to the eye than to the median notch in the lip. The dorsal surface of the back shows some small granular tubercles. There is an indistinct ridge from the nostril across the loreal region to under the edge of the eye, and a slight depression on the snout. The vocal sac is evident externally and is limited posteriorly by a fold on the neck rather than on the breast; the fasciculi of the vomerine teeth are completely behind the level of the choanae. They are conical, bearing three (or two) teeth. The snout is very short and the palate anterior to the choanae is obscured by the maxillary shelf.

The paratype specimen has more markings on the back than the type has. There is an indefinite dorsolateral mark on each side extending (more or less brokenly) to the rump and another mark following the temporal fold from the eye to some distance on the side. There are a few dorsal spots on the head.

The relationship of this small species is obscure. The paired toothlike processes in the lower jaw are not, to my knowledge, present in other Central American species.

Hyla rufiocularis sp. nov.

Figure 47

Type: K.U.M.N.H. No. 28216, Isla Bonita (American Cinchona Plantation), eastern slope of Volcán Poás, Costa Rica, July 28, 1947, Richard C. Taylor and Edward H. Taylor, colls.

Paratypes: K.U.M.N.H. Nos. 28204-28210, July 14, 1947; Nos. 28211-28215, 28217-28222; R.C.T. Nos. 430, 512, 513, 515, 518, 520, all from Morehouse Finca, four and one-half miles S of Turrialba,

^o U. M. M. Z. No. 70179.

July 15-16, 1947; Nos. 31072-31078, Moravia, Aug. 16, 1951; R.C.T. Nos. 2437-2438, 2441, 2443-44, 2446-47, 2449, 2454, 2457, Isla Bonita, July 22 to Aug. 3, 1947.

Diagnosis: Small species, 34 mm. ♀; prominent eye, red in life; head depressed, wider than body; olive or brownish above, with a narrow white labial line connecting with a larger white spot below eye, and continuing to groin; this bordered below by a narrow dark pigmented line; fingers with a vestige of a web; outer toes at least three-fourths webbed; a narrow inner and a narrow outer tarsal fold; choanae large; vomerine teeth in two fasciculi between

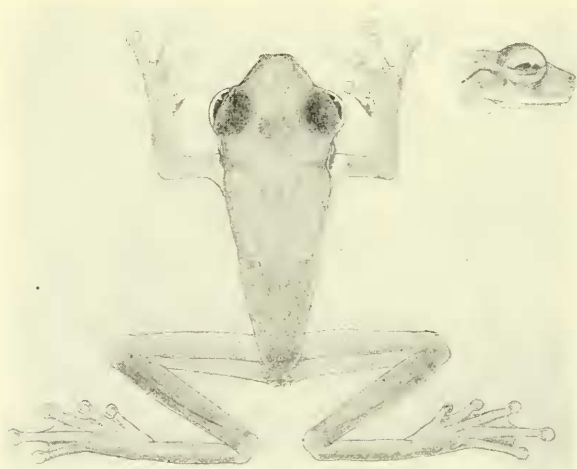


FIG. 47. *Hyla rufoculis* sp. nov. K.U.M.N.H. No. 28216; Isla Bonita, Volcán Poás, Costa Rica; snout-to-vent length, 34 mm.

choanae, about one third size of choanae. Males with vocal slits, and an external vocal sac.

Description of type: Head broad, broader than body, its width (12 mm.) greater than its length (10.8 mm.); eyes very prominent; interorbital area slightly depressed; a depressed area between the canthi extending between swollen areas about nostrils, and continuing on to front of snout; canthus distinct, rounded, curving forward to a point above nostril; loreal region concave, the upper part sloping abruptly, the lower part, obliquely, to lip; tip of snout rounding in profile, extending about one millimeter beyond mouth. Tympanum distinct, its upper third covered by a strong slightly overhanging, supratympanic fold that curves down in front of arm insertion; distance between tympanum and eye (2.55 mm.) approxi-

mately twice diameter of tympanum (1.3 mm.); length of eye opening (4.1 mm.) more than three times diameter of tympanum; length of snout, 3.8 mm., the distance between eye and nostril, 3.1 mm.; width of an eyelid (flat) (3.1 mm.) less than interorbital distance (4 mm.); distance between nostrils, 3 mm.; trace of a fine ridge from nostril back to eye; choanae large, a little longer than wide, separated from each other by a distance (3.3 mm.) little more than three times the greatest diameter of a choana; vomerine teeth in two fasciculi between choanae, separated from each other by width of one fasciculus and from choanae by a distance equal to length of one and one-half fasciculi; palatal glands open into a sinuous, discontinuous groove, a little closer to the choanae than to end of palate; transverse palatal ridges strongly elevated; tongue longer than wide, distinctly notched or emarginate behind, free for one fifth of its length (males with vocal slits, and a vocal sac).

Arm rather long, the wrist extending two millimeters beyond tip of snout; inner fingers with a vestige of a web; three outer fingers about one-fifth to one-sixth webbed; discs large (1.6 mm.), much larger than the tympanum; fringes on edges of fingers narrow; inner metacarpal tubercle well developed; the palmar tubercle tri- or quadripartite, not especially distinct; a more or less continuous fold under forearm; distal subarticular tubercles of two outer fingers bifid.

Leg with the heel reaching to the middle of eye; inner toe about one-third webbed; four outer approximately four-fifths webbed, the webs reaching to near the discs, but deeply excised; a small, rounded, inner metatarsal tubercle; a small but distinct outer tubercle; a fine, angular, inner tarsal fold, and a similar outer tarsal fold continuous with a slight fringe on outer edge of outer toe; legs folded at right angles to body, the heels overlap 4 mm.

Skin on dorsum and sides generally smooth but under a lens appearing finely corrugated; under part of thighs, venter, and chin granular, the breast wrinkled without a distinct fold; under surface of arms smooth; anal flap short, the vent high, immediately followed by a groove, flanked by a pair of large tubercles (partly covered by the anal flap) and a slight ridge terminating behind in another pair of tubercles; the anterior tubercles more or less fluted; a few other slightly enlarged tubercles or granules, scattered on ventral surface of thighs; granules on palm and sole rather ill-defined; practically no trace of an axillary web.

Color: Above nearly uniform red-brown on dorsum, upper part of sides and on dorsal surfaces of limbs. A cream line on lip con-

necting with the subocular eye-spot, and continuing along middle of side to groin; venter yellow-flesh; concealed parts of limbs canary-yellow, the color under hand and feet less intense; posterior face of femur pigmented.

Measurements in mm. of Hyla rufoculis sp. nov.

	Type	28215	28207
Snout to vent	34	28	28
Length of head	10.8	10	9.8
Width of head	12	10.4	10
Length of snout	3.8	3	3
Length of eye	4.1	3.6	3.7
Tympanum	1.25	1.1	1.2
Interorbital width	4	3	3
Arm	21	18	17
Hand	9.5	8.4	8
Leg	51	45	44
Tibia	17	15	15
Foot and tarsus	22	19	18.8

Remarks: The series of specimens taken at the Morehouse Finca near Turrialba differ somewhat from those taken at the type locality. The measurements are nearly identical, but the specimens are an intense brown with some scattered darker flecking visible when the specimens are submerged in water. The dark stripe below the lateral yellow stripe may be all but obsolete in some, while in others it is present or consists of small spots or flecks. The chin occasionally has small spots. The breast is granular and the under surfaces of the arms show some trace of fine granulation. The skin is much more strongly corrugated on the dorsal and lateral surfaces.

Topotypic males differ in having a relatively narrower interorbital width and slightly larger eyes; vocal slits are present but there is no external evidence of a vocal sac.

Specimens were found along small rivulets at night, calling from the leaves of low plants. The call is reminiscent of *Hyla miotympanum*, with which species it is probably related.

Two other Costa Rican forms that may be confused with these are *Hyla uranochroa* and *Hyla alleci*, the latter occurring in the same immediate locality as *rufoculis*. The differences from this latter species are discussed under *H. alleci*.

In *Hyla uranochroa* the following differences obtain: eye silvery in color; tympanum large, separated from eye by a distance a little less than its own diameter; posterior face of thigh unpigmented; a strong white line covers anterior part of anal flap; area about vent

deep brown; tubercles below anus covered with an enamel white; chin pure white; a pure white line on lip widens slightly under eye and continues to groin, not bordered below by a dark stripe; size larger, 39 mm., head width 14 mm. in females.

The specimens from the Morehouse Finca and Moravia were found on water plants in small spring-fed streams. Specimens from Isla Bonita were taken from the immediate environs of a small spring.

Hyla alleci sp. nov.

Figure 48

Type: R.C.T. No. 775. American Cinchona Plantation (Isla Bonita) eastern slope of Volcán Poás, Costa Rica. Richard C. Taylor coll., July 28, 1947.

Paratype: R.C.T. No. 774. Same data and collector.

Diagnosis: Medium sized frogs (36 mm.) with a much flattened head and body; above, olive green in life; canary yellow below (reddish lavender in preservative); *eye red in life*; tympanum longer than high with a sharp rim, its diameter more than half length of eye; eye shorter than snout; vomerine teeth in tiny fasciculi between choanae, each about one fourth size of large choana; outer fingers less than one-third webbed; toes except inner, about three-fourths webbed; heel to front level of eye; finger discs about one half of tympanum; pupil horizontal.

Description of type: Head and body depressed, the eyes prominent; canthus rounded, curving slightly; width of head (12 mm.) a little less than length (12.5 mm.); area about nostrils swollen, but a very indistinct depression between them; nostrils much closer to notch in upper lip than to eye; tympanum large, a little longer than high (2.35 mm. x 2.1 mm.), its upper edge concealed by the supratympanic fold, directed slightly upward, and separated from eye by a distance equal to nearly two thirds diameter of tympanum; eye large, its length (4 mm.) distinctly less than length of snout (5 mm.) but nearly equal to its distance from nostril; interval between nostrils (3 mm.) much less than eye length; width of an eyelid (3 mm.) less than interorbital width (4 mm.); canthus rostralis rounded, upper part of loreal region nearly vertical, lower part sloping obliquely to lip, the region strongly concave; profile of snout curving somewhat outward beyond nostrils to lower lip; snout not or scarcely projecting.

Choanae large, longer than wide, separated by a distance equivalent to three times length of one choana; vomerine teeth in two

tiny elevated fasciculi, each about one fourth size of choanae and separated from them by a distance twice length of a fasciculus and from each other by once this distance; tongue a little longer than wide; a pair of vocal slits in mouth almost entirely behind posterior level of tongue; palatal glands opening into two transverse grooves, curving forward closer to anterior part of palate than to anterior level of choanae; openings of the Eustachian tubes equally as large as choanae.

Arm with wrist reaching slightly beyond tip of snout; upper arm very slender, forearm relatively much thickened (as in *Agalychnis*);

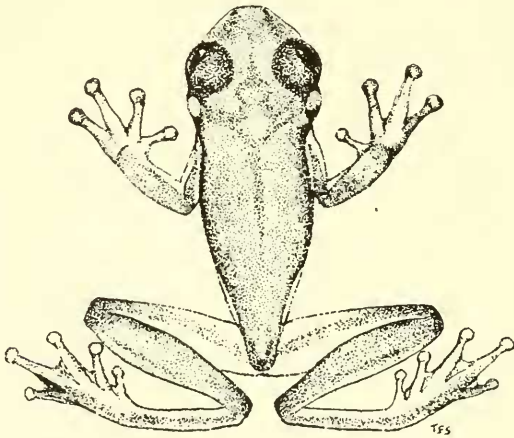


FIG. 48. *Hyla alleei* sp. nov. R.C.T. No. 774, Paratype; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 35 mm.

a very slight axillary web; between inner fingers scarcely a trace of web; three outer fingers a little more than one-fourth webbed; thumb seemingly not opposable; a large inner metacarpal tubercle at side of base of first finger; a very small area of nuptial asperities scarcely darker than surrounding tissue; distal subarticular tubercle of fourth finger on right hand bifid, single on left hand; palmar tubercle indistinctly tripartite; numerous granules on palm; a continuous ridge on under side of arm; skin not granular on under side of arm.

Leg short, the heel reaching to anterior edge of eye; no distinct inner tarsal fold or ridge; no outer fold; inner metatarsal tubercle rather small, flattened; outer tubercle smaller, indistinct, scarcely discernible from other granules on sole; inner toes one-half webbed,

other toes three-fourths webbed; discs on fingers much smaller than tympanum, those on toes smaller than those on fingers.

Skin of dorsum, head, sides, arms and legs very smooth with no or only very indistinct corrugation when examined under a lens; chin very finely granulate, breast indistinctly so; venter and under side of thigh strongly granulate; on either side of vent soft tubercles; a groove, immediately behind vent, flanked on either side by several enlarged tubercular granules, arranged somewhat symmetrically.

Color in life: Olive-green on dorsal surface of head and body, on dorsal surface of forearm; a narrow streak on the dorsal surface of upper arm, a narrow band on femur, dorsal surface of tibia and tarsus, and along outer part of foot; ventral and lateral surfaces of body and limbs lemon-yellow; a cream-yellow line on upper lip, very slightly widened below eye, continues along side tending to merge with lateral coloration; no pigment on anterior or posterior face of femur; hands except for outer side of fourth finger, and foot except for outer toe, yellow; anal flap, deep lavender for most of its length. A yellow band crosses anal flap, behind which, on the very edge, is a small lavender area.

Measurements of type and paratype respectively (in mm.): Snout to vent, 36, 35; length of head, 12.5, 11.8; width of head, 12, 11.2; length of tympanum, 2.35, 2.3; length of snout, 5, 4.8; length of eye, 4, 3.8; interorbital width, 4, 3.6; arm, 21, 21; hand, 10.5, 9.6; leg, 51.4, 50; tibia, 17.1, 17; foot and tarsus, 24, 22.5.

Remarks: The paratype agrees in all essential characters, save that the tongue shows a distinct posterior median notch (somewhat indicated in type); the tibiotarsal articulation (heel) reaches a little beyond middle of eye; vomerine fasciculi are a trifle larger, situated between the choanae and reaching neither their anterior nor their posterior levels. The coloration is identical.

The relationship of this form is with *Hyla rufiocularis* and *Hyla uranochroa*. The former species is found in the same locality and likewise has a red eye. The calls are different and the males are distinctly smaller; the posterior parts of their thighs are strongly pigmented and in preservation the color is not lavender; the upper arm is not so slender and there is usually a dark line below the light lateral line; the tympanum is smaller, its diameter about a third of the eye length.

The species strongly resembles a species of the genus *Agalychnis* in the characteristic distribution of pigment, the characteristics of

the upper and forearm, the red eye, and the coloration of the body. The eye however has a distinctly horizontal pupil. The species is named for Dr. Ralph Allee, the genial director of the Inter-American Institute of Agriculture at Turrialba, C. R., where I maintained my headquarters for a considerable part of my stay in Costa Rica.

The two specimens were found at a small spring at night by following their calls.

Hyla uranochroa Cope

Figure 49

Hyla uranochroa Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 103-104; pl. 27, fig. 4 (type locality, near Sipurio, Costa Rica); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 38 (no specimens); Boulenger, Catalogue of the Batrachia Salientia s. Ecuadata in the collection of the British Museum, 2nd. ed., 1882, pp. 377-378 (one ♀ specimen, Costa Rica); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, pp. 276-277, Sept. 1901, pl. 70, fig. D (Rio Sucio, La Palma, alt. 1600 meters); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 254; Dunn, Occ. Papers Mus. Zool. Univ. Michigan, No. 151, July 1, 1924, pp. 2-3, pl. 1, figs. 1, 2 (tadpoles and color in Panamanian specimens, La Loma, Panamá).

Diagnosis: The species may be diagnosed by the following characters: greenish in life, becoming blue or bluish lavender in preservative; eyes red in life, becoming whitish or silvery; the tympanum large, more than half diameter of eye; canthus distinct but rounded; vomerine fasciculi small, widely separated, about one third size of choanae; distinct lateral white stripe from tip of snout to groin, widening under eye; chin white, venter yellowish; anal region white except on edges of vent; a narrow pigmented stripe on femur; remainder flesh-color without pigment (yellowish in life); outer fingers about two-fifths webbed; toes approximately four-fifths webbed.

Description of species: (M.C.Z. No. 10249 from La Loma, Panamá.) Head width (14 mm.) greater than length (12.2 mm.); eyes very prominent directed somewhat forward; canthus rostralis distinct, its edge rounded, curving slightly to nostril; upper part of lores sloping precipitately, lower part sloping obliquely to lip, leaving lores somewhat concave; areas about nostrils not distinctly swollen, however a slight depression at the dorsal base of snout is continued indistinctly to between nostrils; tip of snout sharply truncate; seen in profile, snout curves out slightly from nostrils to lip; notch in upper lip scarcely perceptible.

Tympanum large, subcircular, directed outward and somewhat upward, the supratympanic fold covering its upper parts, its diameter (2.5 mm.) more than half length of eye (4.4 mm.), its distance from eye about equal to its own diameter; length of eye

greater than snout length (3.9 mm.); interval between nostrils (3 mm.) less than distance of nostril to eye (3.3 mm.), their distance from median notch on lip less than their distance from eye; width of eyelid (3.3 mm.) less than interorbital width (4.9 mm.); supratympanic fold curving gently from eye over tympanum, then turning down suddenly to behind angle of jaw; choanae moderately large, lateral, separated by a distance equal to approximately four times the width of one choana; vomerine teeth



FIG. 49. *Hyla uranochroa* Cope. M.C.Z. No. 10250; La Loma, Panamá; snout-to-vent length, approximately 36 mm.

in two small, slightly diagonal fasciculi between choanae, but not reaching their posterior level, separated from each other by a distance greater than their distance from choanae; latter larger than openings of Eustachian tubes; tongue subcircular slightly emarginate behind, not or scarcely free behind (males with vocal slits).

Arm and leg laid against body, the knee and elbow do not touch; arm extended forward, the wrist extends considerably beyond tip

of snout; inner toes with a web remnant; outer fingers about two-fifths webbed but web emarginate; discs large, distinctly smaller than the tympanum, but a little larger than discs on toes; inner metacarpal tubercle moderate, its length in the length of inner finger about two and one-half times; palmar tubercle indistinct; granules on palm present but not strongly developed; a tubercular fold on under side of arm.

Leg relatively short, the heel reaching to near front edge of eye; toes slightly less than four-fifths webbed, the web not reaching discs. Inner metacarpal tubercle small, outer almost obsolete; distal subarticular tubercles of two outer fingers usually more or less bifid; legs folded at right angles to the body, the heels overlap 4 mm.; a moderately-distinct inner tarsal fold.

Skin of head and body generally smooth on dorsal surface; laterally (under a lens) it is seen to be roughened by minute elevations each with a minute pit; axillary web absent or very indefinite. Chin smooth anteriorly, granular posteriorly; breast, venter and under side of thigh strongly granular, the granules in anal region especially large and irregular; vent covered with a short wide flap.

Color: Dorsally green in life, yellowish below and on concealed surfaces, the two color separated by a line of enamellike white, beginning on snout, following edge of lip and widening under eye, continued to groin; a sharply defined white band across the anal flap and a considerable white area below the dark colored vent; a more or less distinct white line on outer edge of arm and leg; eye red in life, silvery in preservation. The color of the preserved specimen is purplish-blue above, with lavender on rump and on exposed surface of tibia and foot; under a lens the surface appears frosted with whitish; a frosted band along dorsal surface of femur; remainder of the thigh flesh-color.

<i>Measurements in mm. of Hyla uranochroa Cope</i>		
	Type	10249
Snout to vent	40 (39)*	38
Width of head	14 (14.5)	14
Length of head	.. (12.6)	12.2
Diameter of tympanum	.. (2.8)	2.5
Length of eye	.. (4.5)	4.4
Length of snout	.. (4.2)	3.9
Arm	22 (24)	24
Hand	10 (9)	11
Leg	55 (54.5)	58
Tibia	.. (18.4)	20
Foot and tarsus	25 (25)	26

* My measurements of the type specimen in parathenses.

Remarks: The difference between the specimen here described and the type is slight. I have no doubt that the specimen is correctly identified.

This species may be confused with two other red-eyed species that occur in Costa Rica. These are the smaller *Hyla rufioculis* and *Hyla alleci*. From this species *Hyla alleci* may be distinguished by the absence of the enamellike coloration of the anal region and the lateral light stripe, although there is a whitish lateral stripe. The whitish frosting is absent from the dorsal surface. Snout longer than eye, head more flattened; coloration of preserved specimens, reddish lavender. The snout is narrower and more rounded from dorsal profile; eyes very dark in preserved specimens; a groove follows vent.

Hyla rufioculis is distinguished by its smaller size, and more reduced webbing on fingers and toes. Its preserved coloration is brown or grayish brown and there is no white anal spot.

I have examined specimens from Sipurio, Costa Rica and La Loma Panamá. The type, U.S.N.M. No. 30651, is soft but most of the essential characters can still be discerned.

Hyla phaeota Cope

Figure 50

Hyla phaeota Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, pp. 358-359 (type locality, Turbo, Colombia, J. Cassin, coll. "1 in. 10 lines long"); Werner, Sitzungsber. Akad. Wiss. München, vol. 27, 1897, pp. 215-216 (Panamá); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 1882, p. 402; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 269; Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, p. 413, 420 (Barro Colorado Island) (places *dolomedes* Barbour as a synonym); Nieden, Das Tierreich, Lief. 46, Anuren I, 1923, p. 261 (Panamá, Colombia, "length to 60 mm."); Gaige, Hartweg and Stuart, Occ. Papers Mus. Zool. Univ. Michigan, No. 357, Oct. 26, 1937, p. 4 (localities in eastern Nicaragua); Taylor, Univ. Kansas Sci. Bull., vol. 28, pt. 1, May, 1942, pp. 80-81, pl. 8, fig. 1, 1a, 1b, 1c (Piedras Negras, Petén, Guatemala); Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, pp. 589-590, pl. 26 (length 56 mm.).

Hyla labialis Peters, Monatsber. Akad. Wiss. Berlin, 1863, p. 463 (Chiriqui, Panamá); *idem*, *ibid.*, 1873, p. 618 (in synonymy *H. phaeota* Cope); Boulenger, Catalogue, *loc. cit.* p. 397, Bogotá (snout to vent 34 mm.).

Hyla baudinii dolomedes Barbour, Occ. Papers, Mus. Zool. Univ. Michigan, No. 129, Jan. 25, 1923, p. 11 (type locality, Río Esnape, Sambu Valley, Eastern Panamá).

Diagnosis: Large species, ♀ 73 mm., ♂ 50 mm., with a single, very large subgular sac; outer fingers one fourth to one-third webbed; inner with only a small vestige; toes four-fifths webbed, the web touching discs on one side at least on all toes but fourth; tympanum large, its diameter five eighths of eye length; tibiotarsal articu-

lation reaches beyond snout; a black spot behind eye passing to side of shoulder, pointed behind, involving entire tympanum; a whitish line on lip continues back and borders the black spot; arms and legs usually barred with darker.

Description of species: Head a little wider than long, rather flattened, its greatest depth at tympanum about 9 mm.; eye moderately prominent, its length 8 mm., slightly less than length of snout;

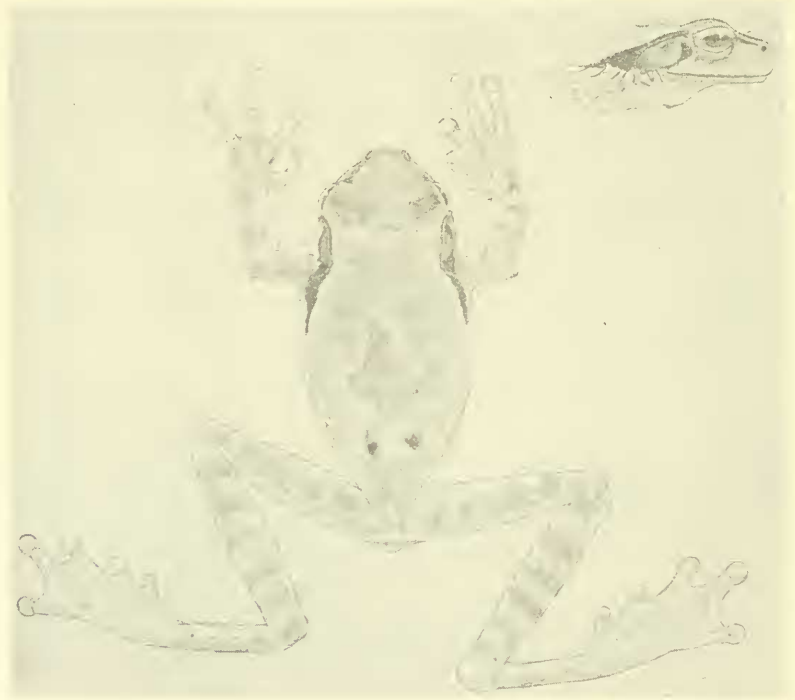


FIG. 50. *Hyla phacota* Cope. K.U.M.N.H. No. 25724; Los Diamantes, Costa Rica; actual snout-to-vent length, 72 mm.

canthus rostralis distinct but somewhat rounded on the edge; loreal region distinctly concave, the nostrils lateral, nearer median point on the lip than to eye; close to the most anterior part of the snout, the area about them not or but very slightly swollen; width of an eyelid (6.6 mm.) slightly less than interorbital width (8 mm.); edge of upper lip swollen, thickened, projecting somewhat below eye and tympanum; a heavy fold from corner of eye bends up and over the tympanum reaching to near shoulder; tympanum irregularly shaped the upper edge covered by fold, longer than high, its

length five eighths of eye length; tip of snout projecting slightly beyond mouth (1.5 mm.)

Tongue large, subcircular, with a small median emargination posteriorly; choanae moderate, somewhat quadrangular, the width of one in distance between, about 3.4 times; vomerine teeth on two strongly elevated triangular fasciculi almost contiguous, and situated between choanae and not or scarcely reaching a line joining posterior edges of choanae; palatal glands open in a long curving groove closer to the anterior end of palate than to the choanae; 67-68 maxillary teeth, transparent white; 18 premaxillary teeth.

Arms long; fingers with broad terminal discs, about one half as large as tympanum, first smallest, other three subequal, about 4 mm. in width; web remnant between first two fingers, three outer nearly one-fourth webbed, but a narrow web-fringe continues to discs; a large elongate tubercle at inner base of first finger; palmar tubercle large, rather indistinct; large undivided subarticular tubercles; supernumerary tubercles on palm; small irregular tubercles on underside of arm.

Leg very long the tibiotarsal articulation reaching 8 mm. beyond tip of snout; an inner tarsal fold, distinct for its entire length; toes about four-fifths webbed (somewhat less in males); a rounded, flattened inner metatarsal tubercle, its anterior edge raised; subarticular tubercles prominent; a small outer metatarsal tubercle; distinct supernumerary tubercles present; disks on toes not or but slightly smaller than those on fingers; when legs are folded at right angles to body the heels overlap 8 mm.

Skin on back smooth (under lens minutely shagreened). Skin on sides covered with a strong reticulation of grooves dividing the skin into distinct irregular islandlike areas; venter, breast, and under thighs with pavementlike, closely juxtaposed granules; chin less densely granulate; anal opening high on thigh, the short flap laterally narrowed; an indistinct groove follows behind opening.

Measurements in mm.: (Nos. 25724 ♀ and 25720 ♂ Los Diamantes, respectively.) Snout to vent, 72, 52; length of head, 22, 16.7; width of head, 25, 14.8; tympanum length, 5, 4; eye length, 8, 6; eyelid width, 6.6, 4.2; interorbital width, 8, 6; arm and hand, 44.5, 29.5; forearm and hand, 35, 25; leg, 123, 94; tibia, 42, 29.5; tarsus and foot, 55, 40.

Color in life: Above olive-green with dim indications of darker spotting. Later this changed to a yellow green with some dark olive marks; chin lavender, washed slightly with olive; legs banded with dark olive; venter below dirty cream white with a lavender

tinge; underside of limbs somewhat more definitely tinged with lavender; underside of feet and hands purplish lavender.

Color in preservative: Brownish above with trace of a brown band across head and eyelids; on middle of back a more or less regular large chocolate brown mark, and two blackish spots on rump; a black stripe from eye to shoulder involving entirely the brown tympanum; arms and legs barred with dark purplish brown; 6 or 7 bars in tibia; tarsus, foot and hand without marks; below uniform light.

Remarks: This form was described by Cope from a small male specimen, "1 in. 10 lines in length." It has a general appearance similar to *Smilisca baudinii* and has probably been the basis for some of the reports of *Smilisca baudinii* in Costa Rica. Barbour described as new from Panamá, a form, *Hyla baudinii dolomedes*, as follows:

"Similar to true *H. baudinii* of Central America, but with very long hind limbs—longer than Central American individuals which I have seen. The tibiotarsal articulation reaches well beyond the tip of the snout. . . . The form is probably worth full specific recognition."

This has been placed as a synonym of *H. phaeota* by Dunn. The voice of this form was a harsh "squawk-squawk", repeated at intervals of one or two minutes.

Specimens were obtained at Turrialba, Moravia, and at Los Diamantes near Guápiles. They were breeding at the latter station, and recently deposited eggs were found in small rain pools. Females are considerably larger than the males.

Hyla gabbii Cope

Figure 51

Hyla gabbii Cope, Journ. Acad. Nat. Sciences, Philadelphia, ser. 2, vol. 8, 1875, p. 103 (type locality near Sipurio, east coast of Costa Rica, Wm. Gabb coll.); Brocchi, Mission Scientifique au Mexique . . . ; Étude des Batraciens de l'Amérique Centrale . . . , livr. 1, 1881, pp. 37-38; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 372; Proc. Zool. Soc. London, 1898, p. 478 (Costa Rica?); Werner, Verh. zool.-bot. Ges. Wien, vol. 46, 1896, p. 355 (Separate, p. 13); (Guatemala. "Irregular large and small yellowish flecks and dark dots"); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 274 (pl. 70, fig. B, type of *H. salvini*); Werner, Abh. math.-phys. Class. königl. Bayer. Akad. Wiss. München, Bd. 22, Abt. 2?, 1903, p. 351; Nieden, Das Tierreich, Lief. 46, Anura I, June, 1923, p. 252; Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, pp. 413-414 (Barro Colorado I., Canal Zone); Proc. Acad. Nat. Sci. Philadelphia, vol. 84, 1932, p. 25 (Ceiba, Honduras).

Hyla salvini Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 372 (figured in Günther, *loc. cit.*, type locality, Cartago and San José, Costa Rica. Here restricted to Cartago.); ? Werner Verh. zool.-bot. Ges. Wien, vol. 46, 1896, p. 350 (page 8 of reprint), (Honduras, see Werner 1903, *loc. cit.*).

Diagnosis: A large *Hyla* (56 mm. snout-to-vent) lacking dark markings on tympanic region and on side of head; a pale labial light line not reaching back to eye; back with several large dark spots, often connecting with a dark band between eyes (all marks occasionally absent as in "*H. salvinii*"); a distinct tarsal fold; toes fully webbed; outer fingers two thirds webbed; skin usually nearly smooth with very small scattered tubercles; palate arched, bear-



FIG. 51. *Hyla gabbii* Cope. K.U.M.N.H. No. 28201; San Isidro el General, Costa Rica; actual snout-to-vent length, 49.5 mm.

ing two elevated, nearly contiguous, transverse fasciculi between choanae; legs with dusky transverse bands.

Description of species: (No. 28201, San Isidro El General.) A moderately large species, the snout-vent length exceeding 50 mm.; head width (17 mm.), a little greater than its length (16 mm.); canthus rounded, the loreal region somewhat concave; area about nostrils a little swollen with a slight depression on base of snout, and continued forward between nostrils; distance of nostril from

eye (4.4 mm.) almost equal to its distance from median labial notch (4.38 mm.); tympanum distinct (2.3 mm. long, 3 mm. high), separated from eye by a distance practically equal to the length of tympanum; eye length (4.8 mm.) greater than its distance from nostril, less than the length of the snout (7.8 mm.); width of an eyelid (4.8 mm.) greater than interorbital width (4.6 mm.); distance between nostrils about 4 mm. In profile the snout slopes forward from the nostrils then becomes rounded to lip, extending beyond lip about .5 mm.

Choanae moderately large, the palate between them a little elevated; vomerine teeth in two transverse fasciculi, each a little smaller than a choana, situated between choanae and not reaching their posterior level, closely approximated mesially, separated from choanae by a distance more than half length of a fasciculus; width of choana in distance between choanae about 4.5 times; openings of palatal glands in a sinuous groove, nearer front of palate than to anterior level of choanae; tongue subcircular, somewhat emarginate behind (male with vocal slits); openings of the Eustachian tubes triangular, smaller than choanae.

Arm with wrist extending slightly beyond tip of snout; first and second fingers with only a web remnant, and slight fringes extending to discs; webs on inner side of second finger and on the outer finger reach to near the base of terminal discs; distal subarticular tubercles of two outer fingers not or very indefinitely bifid; inner metacarpal tubercle long, outer palmar tubercle large, usually, at least partially divided; discs on fingers large (2.4 mm.), larger than tympanum, nearly half eye length; a beaded fold along under face of forearm; none or only negligible axillary web.

Leg long, heel reaching 3 mm. beyond tip of snout; toes fully webbed; a distinct sharp-edged tarsal fold that curves toward the heel; inner metatarsal tubercle small, scarcely discernible; subarticular tubercles small; no outer tarsal fold.

Skin generally smooth with fine scattered tubercles; under a lens the skin is finely corrugated, head, especially loreal region, noticeably so; a straight supratympanic fold from eye to above arm covering the upper edge of the tympanum; under surface of arms, chin, breast, venter, and under surface of the thigh, granular, and without a trace of a breast fold; a small anal flap; vent high; a small groove follows vent, flanked on each side by elongate slightly raised areas.

Color: Above brown with an interorbital bar and a series of narrow connecting spots on the back; limbs barred with dusky;

ventral surface of body cream-flesh; under side of feet and outer part of hands dark; sides with a few minute dark flecks, groin finely reticulate with black and white; front and back of thigh with some minute white flecks or reticulations; snout bearing a whitish line along lip border; no dark spots on sides of face.

Measurements in mm.: (K.U.M.N.H. No. 28201, and R.C.T. No. 980 respectively.) Snout to vent, 49.5, 46; width of head, 17, 16.4; length of head, 16, 14.8; length of snout, 7, 6.7; length of eye, 4.8, 4.8; greatest diameter of tympanum, 3, 2.4; arm, 31, 26; hand, 15.8, 13; leg, 82.3, 74; tibia, 31, 27.5; foot and tarsus, 38, 34.2.

Remarks: Three of the specimens are from San Isidro El General on the Pacific slope, at an elevation of approximately 706 meters.

I suspect that the species is confined to relatively low land. It may readily be differentiated from two other large hylids, *Smilisca baudinii* and *Hyla phaeota*, by the presence, in the two latter, of black marks on the temporal region, and the presence usually of spots on the lips. *Smilisca baudinii* has a pair of vocal sacs on the chin in males.

One specimen, No. 53722, from "Río Calabre," Panamá, has the dorsal ground color very light tan, and heavy blackish markings; the dark reticulation on the side being heavy, rather than fine, inclosing rounded light spots; posterior face of the femur dark, with a few cream flecks.

Of two specimens (Michigan Mus. of Zoology No. 70178) from San José, one has the dorsal color grayish without black marks, corresponding to the form described as *Hyla salvini* Boulenger, which with the information at hand is treated as a synonym of *H. gabbii*. The second specimen is dark gray brown and has some indefinite darker markings that are indistinctly visible when the specimen is submerged in water or alcohol.

Specimens were found in bromelias at San Isidro El General.

Hyla wellmanorum sp. nov.

Figure 52

Type: Kansas Univ. Mus. Nat. Hist. No. 30302 ♀; collected at Bataan, Costa Rica (Caribbean drainage); July 20, 1951, E. H. Taylor, coll.

Paratypes: Nos. 30300-30301. Same data. R.C.T. No. 2899, Los Diamantes, 1947, R. C. Taylor, coll.

Diagnosis: Medium-sized frogs (♂ 44 mm. female probably larger) without tarsal fold, outer fingers less than one-fifth webbed, the outer toes two-thirds webbed; skin smooth above; diameter of

tympanum approximately two-thirds diameter of eye; canthus distinct but rounded; tympanum much larger than largest finger pad; heel reaches to nostril.

Description of type: A medium-sized frog (44 mm.), with the width of the head (16 mm.) slightly greater than length (15 mm.); tympanum somewhat irregularly shaped, large, its upper part hidden under a fold arising from eye and curved down behind tympanum, its greatest diameter (3.5 mm.) equal to approximately two thirds length of eye (5 mm.); distance of nostril from eye a little greater



FIG. 52. *Hyla wellmanorum* sp. nov. Type. K.U.M.N.H. No. 30302; Bataan, Costa Rica; actual snout-to-vent length, 44 mm.

than its distance from median notch in upper lip; mesial length of snout (5 mm.) equals eye length; distance between tympanum and eye (2.3 mm.) less than diameter of tympanum; width of an eyelid (4 mm.) less than interorbital distance (5.5 mm.); distance between nostrils 4 mm.; top of head slightly concave in medial occipital region; canthus rounded, curving forward from eye; upper part of loreal region sloping abruptly, lower part sloping obliquely to lip, the loreal region in general concave; areas about nostrils swollen, with a slight depression between, nostrils not terminal.

Choanae large, with a somewhat rectangular shape, the length much greater than width; elevated fasciculi of the vomerine teeth distinctly smaller than choanae, the fasciculi between anterior half of choanae almost contiguous mesially, separated from choanae by a distance half that of a single fasciculus; tongue large, broadly

cordiform, notched behind, only the posterior edge free; (vocal slits present in males).

Arm moderately long, the forearm reaching halfway beyond snout; a small web remnant between outer fingers (one fifth or less webbed); no trace of web between first two fingers; discs much smaller than tympanum; a large metacarpal tubercle; palmar tubercles indistinct; distal subarticular tubercles of fingers usually single, that of outer finger somewhat bifid, a broad thickened ridge on under side of arm.

Leg moderately short, the heel reaching to nostril; when legs are folded at right angles to body the heels overlap approximately 5 mm.; heel and elbow touch when limbs are adpressed; inner toe about one third webbed, outer toes approximately two thirds webbed; a moderately large inner metatarsal tubercle; a small distinct outer tubercle; no distinct tarsal fold, but there is a low thickened ridge more or less discernible.

Skin generally smooth, but under a lens a very fine corrugation is evident; a very slight axillary web present; supratympanic fold may continue a considerable distance on side as a loose skin fold; a low tubercular ridge crossing above vent, more or less distinct; an anal flap very short; vent followed by an indistinct groove bordered by larger flattened tubercles, two of which are white (yellow in life); chin smooth, breast without tubercles; venter and most of space on under surface of thigh granular; indication of a slight breast fold.

Color: In life, light yellowish brown above, growing lighter on sides; below and on concealed surfaces nearly pure white; some pigment on under surface of foot; head with some indefinite spotting above and some fine brownish flecks but lacking spots on sides of snout; a pair of indistinct longitudinal stripes on back connected posteriorly; lip with a very narrow light line bordered on (ventral) edge of upper lip with a fine line of pigment; one subocular eye spot; no black spot from eye across tympanum, but a few fine brown flecks present on side of neck and on limbs; bars on limbs faintly discernible; outer finger and arm, outer toe and tarsus, edged with a narrow white line bordered below with an irregular narrow line of pigment; above vent extending an indefinite distance on thigh, is a transverse white line bordered below by a darker line that can be traced along the thigh nearly to knee; some cream white marks below vent.

Measurements in mm. of Hyla wellmanorum sp. nov.

	NUMBER		
	30302	30300	30301
Snout to vent	44	37	37
Width of head	16	14	14.2
Length of head	15	12.5	13
Length of eye	5	4.4	4.4
Length of snout	5	4.2	4.1
Arm	27	22	21
Leg	72	57	60
Tibia	23	19	19
Foot and tarsus	32	25.2	27

Variation: The two male paratypes differ. One is lighter than type, with a pair of darker brown lines on the back connected across the shoulders. A dark line is present from the eye to the nostril and there are one or two spots between eyes. The dorsal coloration is bordered by a fine line of pigment on the sides and the vocal sac is slightly pigmented with black.

No. 30301 is lavender brown with irregular black marks on back while the lower part of the sides are light, flecked with black. The soles of hands and feet have scattered pigment. A nuptial swelling at the base of the first finger is covered with light brown asperities, the first finger being somewhat opposed to the other fingers. The heels in the paratypes barely reach to the anterior edge of eye.

Relationships: The species somewhat resembles the young of *Smilisca baudinii* but the large skull process is wholly missing. The difference from *phaeota* and *gabbii* is in the shorter leg, lessened webbing of the fingers and toes, and the absence of a definite tarsal fold. I suspect that it is related to the last mentioned species.

Specimens were found on the ground near a rain pool at night, by following the direction of their call. No others were heard.

The species is dedicated to my friends, Dr. and Mrs. Frederick Wellman, who contributed greatly to making my stay at Turrialba a pleasant one, and who assisted greatly in furthering my work.

Hyla cherrei * Cope

Hyla cherrei Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, pp. 195-196 (type locality, Alajuela, Costa Rica, R. Alfaro, coll.).

Hyla cherrii Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1901, p. 264 (Günther's locality, "Rio Alfaro" is probably deduced from the "R. Alfaro" of Cope which is, I believe, intended for the collectors name).

The type of this species cannot be found in the U. S. National Museum collection at the present time and is believed to be lost.

* The spelling of this name should probably be *cherrii* since the species is dedicated to Mr. George K. Cherrie.

None of the specimens of Costa Rican hylids I have been able to examine are referable to the species. In consequence, I quote the original description. The diagnostic characters presented by Cope are: A sharp canthus rostralis, vomerine teeth between the middle of choanae, elongate notched tongue, very large choanae, fingers without web.

Description of species: "Vomerine teeth few, opposite the middle of the very large choanae, at the apex of a ridge which proceeds from the anterior margin of the latter. Ostia pharyngea round, large, but smaller than the choanae. Tongue longer than wide, but little free, and openly notched posteriorly. Tympanic drum distinct, one-half the area of eye, and equal in vertical diameter. Iris dark. Manus almost without web; pes fully palmate. Thumb not opposed. Heel of extended hind limb reaching end of muzzle. Canthus rostralis straight angular, lores vertical. Width of interorbital space 1.5 times the width of an eyelid. External nostrils terminal a little nearer the eye than the diameter of the latter. Muzzle not prominent, vertical in profile. Skin smooth above.

"Head and body above pigmented probably with yellow, in abrupt contrast to the color of the rest of the integument, from which it is separated from the orbit to the sacrum by a narrow white stripe. Colors otherwise uniform straw-color, the limbs pigmented on the exposed surfaces; the humerus and femur not pigmented."

Length of head and body, 26 mm.; length of head to canthus oris, 5 mm.; width of head at canthus oris 8 mm.; length of forelimb, 17 mm.; length of forefoot, 6 mm.; length of hind limb, 45 mm.; length of hind foot, 20 mm.; length of astragalo-calcaneum, 8.5 mm.

No. 253, Alajuela, R. Alfaro.

Remarks: "This small and brightly colored species differs from all others known to me in the combination of characters it presents. The sharp canthus rostralis, anterior vomerine teeth, elongate tongue, large choanae and webless fingers are not found together in any other species. It is dedicated to Mr. Geo. K. Cherrie, of San José, to whom I am indebted for the opportunity of studying the present collection."

Hyla rivularis sp. nov.

Figure 53

Type: K.U.M.N.H. No. 28197. American Cinchona Plantation, (Isla Bonita), eastern slope of Volcán Poás, Costa Rica, elevation 5,500 ft., August 1, 1947, Richard C. Taylor and Edward H. Taylor colls.

Paratype: K.U.M.N.H. Nos. 28196, 28198; R.C.T. Nos. 779, 780, 2063, 2066; same locality and collectors.

Diagnosis: A small species, ♂ 31 mm., ♀ 35 mm., snout-to-vent length. Above generally yellowish olive with or without dorsal markings or network; below with small brownish flecks scattered on posterior part of venter, on sides, and on front, back, and ventral surfaces of femora; canthus sharp, angular; profile of snout strongly cut back under, leaving tip of snout extending beyond lip; heel reaches to eye; tympanum partly (rarely completely) hidden, separated from eye by a distance twice its own diameter.



FIG. 53. *Hyla rivularis* sp. nov. K.U.M.N.H. No. 28197, Type; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 31 mm.

Description of type: Head approximately as wide as body, the snout somewhat narrowed and bluntly pointed; width of head (9.6 mm.) equal its length (9.5 mm.); profile of snout cuts back under nostrils to lip, leaving tip projecting noticeably; canthus rostralis sharp, angular, straight, the upper part of loreal region nearly vertical, the lower part sloping obliquely to lip; the loreal area rather concave behind nostril, which is low (.8 mm. below the canthal level); region about nostrils not swollen; top of head to tip of snout, flat without depressions; tympanum covered with skin, but its outline more or less visible, its diameter approximately 1.3

mm. separated from the eye by a distance of 2.2 mm.; length of eye opening (3.3 mm.) greater than its distance from nostril (3 mm.) and likewise greater than snout length (3.15 mm.); width of an eyelid (2.5 mm.) less than interorbital width (2.9 mm.); a strong fold from eye above tympanum runs back slightly diagonally, then curves down considerably behind jaw angle.

Choanae small, nearly circular, well separated, the diameter of one (.6 mm.) in distance between (2.3 mm.) nearly four times; vomerine teeth in two fasciculi each considerably larger than a choana, situated between posterior part of choanae and extending much behind choanae, the two tooth-rows slightly diagonal; tongue broadly oval, longer than wide, free behind for about one fifth of its length; ample vocal sac visible; the vocal slits in mouth elongate.

Arm moderate, the wrist extends one millimeter beyond snout; a small but distinct axillary fold; first finger not opposed, the distal subarticular tubercles of the first, third, and fourth fingers double or bifid; terminal discs on fingers moderate, the largest, on third finger is 1.6 mm. while that on first is 1 mm. in width; a web vestige between first two fingers; outer fingers one-fifth (or a little less) webbed, the fringe on both sides of digits extending to discs; a thickened continuous somewhat tubercular ridge on under side of arm; inner metacarpal tubercle large, its upper surface covered with nuptial asperities that extend into top of the finger, (the area covered however is much smaller than is usual in hylid forms).

Heel reaches to middle of eye; no inner metatarsal ridge or fold; a suggestion of a thickened outer ridge with an uneven surface; small inner metatarsal tubercle; outer obsolete; inner toes one-third webbed; other toes two-fifths to three-fourths webbed, the fringe continued to discs, which are a little smaller than finger discs; elbow and knee do not, or barely touch; heels (the legs being folded) overlap 2 mm.

Skin smooth on back and sides of head and body, the tibial surface being slightly roughened; chin and breast smooth; belly and under surface of femur with large granules; vent high, the surrounding area fluted, with a dim groove running down behind it, flanked by some enlarged flat tubercles at some distance from vent.

Color: Light, grayish-tan above with darker olive-brown markings; concealed parts of sides and venter, pinkish flesh with yellow on concealed surfaces of limbs, hands and feet; lips gray. Venter, under side of thigh, tarsus, and forearm flecked with light brown; considerable pigment on under side of foot, less on hand.

Measurements of type and paratypes of Hyla rivularis sp. nov.

	28197 ♂	28198 ♂	28196 ♀
Snout to vent	31	30	35
Width of head	9.6	9.7	11
Length of head	9.5	9.5	10.6
Length of eye	3.3	3.3	4
Length of snout	3.15	3.15	3.2
Arm	18.2	19	20
Hand	9	9	9.5
Leg	45.2	43.8	49
Tibia	15.3	14.3	16
Foot and tarsus	22	21	23.2

Variation: Four of the specimens show rather heavy olive dorsal spotting or reticulation. In one specimen the spots are arranged in six transverse irregular blotches, the outer edges of which may be in contact. Another has the larger blotches nearly obsolete with very numerous minute darker olive flecks. One specimen R.C.T. No. 2063 is nearly uniform light gray-tan above with the darker markings all but obsolete, the ventral brown flecks likewise scarcely discernible. The female is lighter, with brown spots on interorbital region, one across the occiput and two lateral irregular longitudinal marks with some smaller brown flecks. Beyond the point where the supratemporal fold turns down, there is an indistinct fold continued to above the arm in most of the specimens. A fold across the breast is evident in the males, barely indicated in the female. The vomerine fasciculi are close together in all, and in some actually contiguous. The snout of the female is slightly depressed between the canthi.

Remarks: Voices of this species had been heard on occasion along a small rivulet filled with high vegetation, but no specimens were taken. One-half day was spent by Mr. Richard Taylor cutting out this vegetation for a distance of some two hundred yards, leaving occasional clumps of plants easy of access. The region was visited at night and with numerous other species, seven specimens of this species were taken in a single weed clump. The female is gravid and while none were found clasping, the males were calling and I suspect that the species was breeding at this time. They were perched on the stems of the plants, about ten feet from the water at a height of five or six feet.

Hyla angustilineata sp. nov.

Figure 54

Type: United States National Museum No. 75060, La Palma, Costa Rica, M. Valerio coll.

Paratypes: U.S.N.M. No. 75061, 75065, same data.

Diagnosis: A small species (30 mm. ♂) with a rather pointed snout, the canthus rounding; a narrow dorsolateral light line from eye, above tympanum to groin; a darker lateral stripe beginning behind eye, extending to groin; chin, throat, venter, and front, ventral and posterior surfaces of thigh strongly spotted with dark brown; fingers without or with only a vestige of a web; first toe with a web vestige; other toes about one third to two fifths webbed; skin smooth; vomerine teeth largely behind posterior level of choanae;



FIG. 54. *Hyla angustilineata* sp. nov. Type. U.S.N.M. No. 760; La Palma, C.R.; snout-to-vent, 30 mm.

deep blackish brown above, uniform or with some obscure markings.

Description of type: Head not wider than body, snout rather pointed. Width of head (11.2 mm.) approximately equals its length (11.1 mm.); tympanum distinct, its upper edge covered with a fold from eye, its diameter (1.5 mm.) contained approximately two and one-half times in the length of the eye (3.8 mm.); distance between tympanum and eye 2 mm.; distance between eye and nostril 27 mm., the length of the snout being 3.9 mm., approximately equal to length of eye; canthus moderately distinct, rounded, the loreal

region sloping obliquely to lip, not or scarcely concave; areas about nostrils slightly swollen but no depression between them; anterior to nostril the snout slopes forward and downward slightly then continues curving from this point to lip; snout thus rounded in profile projecting about 1.3 mm. beyond the mouth; width of an eyelid (2.7 mm.) less than interorbital width (3.1 mm.).

Choanae small, circular, the distance between them (2.9 mm.) from five to six times diameter of one choana; vomerine teeth in two compact fasciculi, narrowly separated from each other, and from choanae by half width of one, situated between but for the most part behind posterior level of choanae, each double the size of a choana; tongue broader than long, notched behind, with only edge free behind; a pair of elongate vocal slits extending rather far forward along side of tongue; arm short, the wrist reaching tip of snout; none or only a very slight axillary fold.

Fingers lacking web or outer with only a trace of a web; distal subarticular tubercles of outer fingers bifid or double; a rather indistinct inner metacarpal tubercle; this together with much of the base of first finger covered with a nuptial swelling, covered with brown horny asperities; penultimate joint likewise more than one third covered; palmar tubercle tripartite or diffuse; outer fingers long, first short with a small disc; discs on outer fingers (1.5 mm.) as large as tympanum; no fold or tubercles under forearm.

Leg rather long, the heel reaching tip of snout; elbow and knee touch when adpressed; heels when legs are folded at right angles to body, overlap 3 mm.; no distinct tarsal fold; a trace of web between the first two toes; second and third toes with web extending one third length of second; three outer toes one-half and two-fifths webbed, inner edges of digits practically lacking a fringe; inner metatarsal tubercle small, outer nearly obsolete; discs a little smaller than those on fingers.

Skin smooth above, without corrugation or tuberculation when seen under a lens; sides of body and limbs smooth; chin with some granulation; breast, venter, and mesial part of thighs heavily granular; vent opening near ventral level of thighs; the anal flap thickened, followed by an indistinct groove.

Color: In life, color unknown; in preservative deep blackish brown with a faint suggestion of darker marking when specimen is submerged in liquid; a broad lighter brown stripe from eye to groin, separated from the dorsal coloration by a very narrow cream or yellow line extending from eye to groin; side of head a little lighter brown, with some darker and lighter areas along lip, and

an indefinite lighter area immediately below the posterior part of eye; all ventral and concealed surfaces of side and limbs including underside of hand and foot, yellowish flesh, strongly flecked and spotted with brown; dorsal part of thigh dark, the front and back with large irregular dark spots; limbs not or obscurely banded; arm bearing several small black flecks, as do tibia and tarsus, but these probably are not remnants of leg bands; digital discs lighter in color.

Measurements of type (75060) and paratype (75065) respectively in mm.: Snout to vent, 30, 29.2; length of head, 11.2, 11.4; width of head, 11.1, 11.2; length of eye, 3.8, 3.8; length of tympanum, 1.5, 1.5; length of snout, 3.9, 4; arm, 17, 17; hand, 9, 8; leg, 47, 45.2; tibia, 17, 16; foot and tarsus, 22, 21.

Variation: The second paratype is young (21 mm. snout to vent). The dorsolateral line and the granules on chin and breast are somewhat indistinct.

Remarks: The species need not be confused with other species in Costa Rica. *Hyla cherrei* has a dorsolateral stripe and the webless fingers of this form but the vomerine teeth are opposite the middle of the large choanae; tympanum half of eye, toes fully webbed, and the humerus and femur are unpigmented, as is the venter.

Hyla moesta, a very poorly described species, has the ventral surfaces black spotted, but it differs in having webbed fingers, tympanum one fourth of eye, head short and wide, brownish black above, sides and the front and back of femora deep black; white spots in axilla and groin; minute white dots on front and back of femur; limbs and hand (except first finger) black.

Hyla nigripes Cope

Hyla nigripes Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, 1875, pp. 104-105, pl. 23, fig. 7 (type locality, 5000 to 7000 ft. elevation on Pico Blanco, Costa Rica) (2 cotypes U. S. N. M. Nos. 30685, 30686); Brocchi, Étude des Batraciens de l'Amérique Centrale; Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 1, 1881, p. 38; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 394; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 278; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 253.

Diagnosis: This form may be diagnosed as follows: rather elongate oval head, with the canthus rostralis curving forward to nostril ("concave"), shallowly concave in loreal region; nostril a little closer to eye than to median point on edge of upper lip; loreal region very oblique; tympanum small, its diameter about one half eye length; skin smooth, fingers about half webbed, the toes four

fifths or more webbed, the web not quite reaching end of the penultimate joint; heel to beyond the tip of snout. Color uniform brown or brown with darker dorsal markings; sides darker than back; feet, dark; posterior face of femur blackish unspotted; sides of throat dusted black; front of femur pigmented; groin with numerous whitish spots in a dark reticulum.

Description of species: Head rather oval, nostrils equidistant from eye and median edge of lip; a slight depression present on snout behind level of nostrils; tympanum medium its diameter (2.3 mm.) almost half length of eye (4.5 mm.) ("orbits large and from four to five times the area of the tympanum"); length of eye distinctly less than length of snout (5 mm.); width of an eyelid less than the interorbital distance; loreal region very shallowly concave sloping very obliquely to edge of lip. Choanae considerably larger than vomerine tooth fascicles which are separated mesially and lie between choanae not reaching behind their posterior level.

Arm moderate; between first two fingers about one fifth webbed; outer fingers about half webbed; ("Digital dilations are moderate, the web of the fingers extending about half-way to the end of the longest, notched deeper than the line of the penultimate phalange.")

Leg long, the heel reaching beyond tip of snout; when limbs are pressed on sides, knee and elbow overlap some distance.

Skin smooth above and on sides; chin, breast and venter, as well as under side of femur granular or areolate.

Color: Above dark brown (probably olive in life) the limbs and feet blackish; sides, from ear back, blackish brown; numerous small cream spots in darker blackish reticulum; front of thigh pigmented; posterior surface of thigh black unspotted; no spots elsewhere; lip brown; venter whitish, sides of throat dusted brown; limbs dimly barred.

Measurements of cotype of Hyla nigripes: (presumably No. 23806. Measurements in parentheses are my measurements taken in 1950.) Snout to vent, 39 (37); length of head, 11 (12); width of head, 13 (13); length of snout, 5 (4.9); tympanum length, — (2.3); eye length, — (4.5); arm, 24 (23); hand, 10 (10); leg, 65 (63.5); tibia, — (21); foot, 16 (16); foot and tarsus, — (26).

Remarks: I have seen certain specimens from Costa Rica identified as being of this species which differ in certain characters and likewise differ somewhat among themselves. While the material is somewhat faded, none of the specimens show the dark coloration one is lead to expect from the type description. It may be that the

dark is intensified in the type due to the very heavy rainfall of the type locality. Until the species is rediscovered on Pico Blanco, there will be a slight doubt as to whether or not the museum specimens referred to the species are correctly identified.

Hyla moesta Cope

Hyla punctariola moesta Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 106 (type-locality, Cordilleras [of Pico Blanco] 5000 to 7000 feet, Costa Rica, Wm. Gabb, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 15.

Hyla punctariola Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata. . . . 2nd ed. 1882, p. 401 (*part.*) Günther, Biologia Centrali-Americana, Reptilia and Batrachia, Sept. 1901, p. 282 (*part.*); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 256-257 (*part.*).
(See comments under *Hyla monticola*).

The very brief description given by Cope follows:

"The fingers are not entirely free, but a web extends between the outer two to the middle of the first phalange. The area of the tympanum in the same is one-fourth that of the orbit. The head is short and wide, and the heel extends nearly or quite to the end of the muzzle."

"Above blackish-brown, sides and femora, except above and below, deep black. Some white spots on sides behind axillae, and some small yellow ones near groin. A few minute white points on front and back of femur, and upper surfaces of feet. Otherwise limbs and hands, except the thumb, are black. Lower surfaces thickly black spotted except on breast and tibia, where the white predominates. One specimen." Length 37 mm.

Hyla monticola Cope

Hyla punctariola monticola Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875 p. 106 (type-locality—"Cordilleras at from 5000 to 7000 feet" elevation; slopes of Pico Blanco, Costa Rica. Wm. Gabb, coll.); and U. S. Nat. Mus. Bull. 32, 1887, p. 15.

Hyla punctariola Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata. . . . 1882, p. 401 (*part.*); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 282 (*part.*); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 256-257 (*part.*).

Hyla punctariola is apparently an eleutherodactylid. Cope was not aware of this and associated three small hylid frogs with that form as subspecies although stating his suspicion that these three were true species. The meager descriptions of the specimens are due, I suspect, to the poor condition of the specimens. One of them *pictipes* is still extant. The other two *moesta* and *monticola* cannot be found in the collection of the National Museum at the present time. I have not been able to recognize these species in any of the material collected or in specimens examined in museums.

The brief data given by Cope of *monticola* follow:

"Color light grayish-brown with large dark-brown spots forming transverse bars, one between the eyes, one in front of the scapulae, one behind the scapulae, and one at the sacrum. Below unspotted white. Limbs with light-brown surfaces above; concealed surfaces pale, unspotted. No inguinal spots; a few specks of brown on sides. Length of head and body .037m."

One specimen only; "fingers not entirely free, but a web extends between the outer two to the middle of the first phalange. The area of the tympanum in the same, is one-fourth that of the orbit. The head is short and wide, and the heel extends nearly or quite to the end of the muzzle."

Hyla boulengeri (Cope)

Figure 55

Scotyopsis boulengeri Cope, U. S. Nat. Mus. Bull. No. 32. 1887, pp. 12-13 (type locality, Nicaragua; type U.S.N.M. No. 13974, MacNeil coll.).

Hyla boulengeri Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, June, pp. 267-268; Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, pp. 339-340, pl. 17, figs. 1, 2 (Kanawa, Sioux Plantation on Río Grande, Nicaragua. Contains certain corrections of the type description.); Nieden, Das Tierreich, Lief. 46, Anura I, June 1923, pp. 251-252; Dunn, Occ. papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, p. 413 (Panamá); and *ibid.* vol. 8, June 7, 1933, p. 62 (Key); Gaige, Hartweg, and Stuart, Occ. Papers, Mus. Zool. Univ. Michigan, No. 357, Oct. 27, 1937, p. 4 [Panamá; Venezuela, British Guiana, and Nicaragua (Río Mico and Recero)].

?*Hyla lancasteri* Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, p. 31, pl. 4, fig. 2. (Placed in synonymy by Dunn, *loc. cit.*).

Diagnosis: Snout low, flattened, elongate; canthus indistinct or absent; eye relatively small, its length equal to three fourths its distance from nostril; choanae very large, the diameter of one equals distance between them. Diameter of tympanum three fourths length of eye; web between first two toes consists of a fringe on second toe.

Description of the species: (K.U.M.N.H. No. 24741. Turrialba, Costa Rica.) Head a little broader than body, its length slightly greater than width; snout flattened, low, without canthus rostralis; area about nostrils raised and swollen; loreal region obliquely sloping; eye relatively small, its length equalling three fourths of its distance from the nostril; interorbital width about equal to width of an eyelid or minutely greater; tympanum large, slightly longer than high, its greatest diameter three fourths of length of eye. Choanae relatively very large, the diameter of one equal or greater than distance between them; vomerine teeth entirely between choanae on two transverse, elevated groups of 8 teeth, touching edge of choanae and practically contiguous mesially; palatal



FIG. 55. *Hyla boulengeri* (Cope). K.U.M.N.H. No. 24741; Turrialba, Costa Rica; actual snout-to-vent length, 45 mm.

glands opening into a straight transverse groove; maxillary-premaxillary teeth 93-96; tongue subcircular, a little longer than wide, slightly notched behind, free behind for about one eighth of its length. Openings of vocal sacs lateral to tongue, widely separated from edge of jaw.

Arms short, fingers practically without trace of web; three outer digits with broad, truncate, terminal discs of nearly equal width, that of inner finger about three fourths the size of those on outer fingers; an elongate tubercle at base of first finger and a large yellow gland on inner and upper surface of its base, nuptial rugosities however not present; three distinct palmar tubercles; palm covered with small irregular tubercles; subarticular tubercles moderately distinct, none bifid.

Leg moderately long, tibiotarsal joint reaching forward to a point halfway between eye and nostril; when legs are folded at right angles to body, heels overlap 7 mm.; toes with broad terminal discs,

that of inner toe practically as wide as those of outer four; first toe practically free from web; inner toes more than three fourths webbed, web reaching the discs on outer side of second and inner side of fifth; one and one-half joints of fourth toe free, inner edge of second toe with a broad fringe; inner metatarsal tubercle rounded, outer a little smaller but equally elevated; an indistinct row of outer tarsal tubercles; supernumerary tubercles on soles; subarticular tubercles distinct and moderately prominent.

Skin with numerous warts and tubercles; three black tubercles on snout arranged in a triangle; indistinct black tubercles between orbits, a fold above tympanum continuing above arm, and a small fold from below tympanum running back a short distance; back and sides with indistinct tubercles, many capped with a small pearl point; anal opening high, the flap bearing two tubercles; a narrow groove extended down from vent; venter strongly granular; chin and throat with smaller, less distinct granules; a row of three or four large tubercles below on lower lip; pearl-capped tubercles on tibia and tarsus.

Color: Dark brownish on head and dorsum, the tubercles dark or black, usually with pearly tubercular tips; venter yellowish; groin yellowish brown, with a larger black spot and some smaller spots; femur strongly barred with black, especially evident on posterior side of femur; tibia less strongly marked except on under surface where the dark marks are distinct; a few scattered blackish dots on under side of femur; foot mottled dark and light; brownish on under surface of foot and toes.

Measurements in mm.: Snout to vent, 45; length of head, 16; width of head, 14.5; tympanum length, 3; arm, 23; leg, 66; tibia, 24; foot and tarsus, 30.

Remarks: A specimen of *Hyla boulengeri* was collected by me the night of June 24, 1947 at Turrialba, Costa Rica. It was discovered by tracing a call in a large clump of papyrus on the edge of an artificial pond on the grounds of the Inter-American Institute of Agriculture. No other specimens were seen, or their calls heard by us during our sojourn in the country in 1947.

I have examined the specimen described by Barbour (Harvard M.C.Z. No. 13062 from Peralta, Costa Rica, elev. 500 meters) as *Hyla lancasteri*. It is based on a newly transformed specimen that is badly preserved. That it is related to *Hyla boulengeri* is evidenced by the free inner toe, large dark spot in the groin, and the dark bars on thigh, especially those on the front. There is webbing on hands and feet despite the fact that the illustration, *loc. cit.*, seemingly

depicts a specimen lacking a web between the toes. There is doubt that it is identical with *Hyla Boulengeri*.

I have examined Harvard M.C.Z. No. 25984 from "Falcon State", Venezuela, which purports to be this species. The specimen however differs in having the skin of the snout smooth; a well-defined dark triangular mark between the eyes, edged with white; groin yellow; lower lip white-edged bordered by a narrow black line; dark marks above and below anal opening; the diameter of tympanum $1\frac{1}{2}$ times in length of eye; choanae about $\frac{1}{2}$ size of that in the Costa Rican specimen; no tarsal fold present; belly granular; chin smooth. It is doubtful that this specimen belongs in this species.

Hyla elaeochroa Cope

Figure 56

Hyla elaeochroa Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 105, pl. 26, fig. 3 (type locality "east foot of mountains near Sipurio, Costa Rica").

Hyla quinquevittata Cope, Proc. Amer. Phil. Soc., vol. 23, 1886, p. 273 (type locality Nicaragua, Bransford collector, type U.S.N.M. No. 14187); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1901, pp. 268-269 (no specimen); Atkinson, Ohio Naturalist, vol. 7, p. 152 (*vide* Noble *loc. cit.*); Noble, Bull. Amer. Mus. Nat. Hist., 1918, vol. 38, pp. 340-341 (specimens from Tuli Creek and Cukra, Nicaragua); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 251.

Hyla rubra (*part.*) Dunn and Emlen, Acad. Nat. Sci. Philadelphia, 1932, vol. 84, p. 25 (synonymizes *quinquevittata* Cope, with *Hyla rubra*).

Diagnosis: Medium small frogs reaching a snout-vent length of 34.5 mm. in females; canthus rostralis practically absent; choanae large; fingers with web remnants; first toe practically free from web; outer toes more than two-thirds webbed; heel reaches approximately to anterior edge of eye; no light spotting on thighs or lateral light stripes present; no trace of a tarsal fold.

Description of species: Head somewhat triangular; eye length 3.2 to 3.5 of length of snout, usually reaching to anterior edge of nostril; diameter of tympanum in eye length, 1.5 times; interorbital width (about 3 mm.) approximately equivalent to width of an eyelid; distance between nostrils equal to their distance from median point on edge of lip; head length (11 mm.) a little longer than width (10 mm.); canthus practically absent, snout long; eye dark; choanae large, separated from each other by a space equal to distance between nostrils or $2\frac{1}{2}$ times greatest diameter of a choana; vomerine teeth in two ridged fasciculi each much less than area of choana. Tongue large, not or scarcely free behind; openings of vocal sacs elongate; externally the sac shows ample folds and is limited by the transverse breast fold.

Skin above in most specimens minutely rugose, the small rugosities usually visible without lens (however some light-colored, unlined specimens show relatively smooth skin and the minute pustules are visible only with a lens); venter, as far forward as the curving skin-fold on breast, strongly granular as is also greater part of under surface of thighs and area below anal opening on posterior thigh surface; neither distinct glandular row of tubercles on forearm nor any trace of an inner or outer tarsal fold.

A trace of web between all fingers, and a ridge or fringe continues along sides of fingers for some distance; none of the sub-

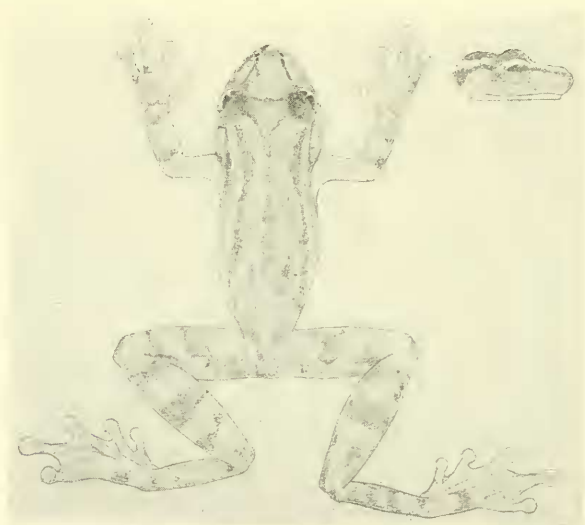


FIG. 56. *Hyla elaeochroa* Cope. K.U.M.N.H. No. 24642; Turrialba, Costa Rica; actual snout-to-vent length, 34 mm.

articular tubercles divided; tubercle on base of first finger moderately large and flat, covered partially with light-colored nuptial asperities, as is upper surface of basal part of first digit. First finger much shorter than second with a smaller disc; discs of outer fingers (1.65 mm. wide) distinctly broader than tympanum; a small axillary web.

Foot with outer toes more than two-thirds webbed, but web nowhere reaching near discs; inner toe nearly free of web; a flat inner and an indistinct small outer tubercle. When leg is laid forward, heel (tibiotarsal articulation) reaches some point on eye, or, chiefly in females, slightly in advance of eye; heels overlap about

3 mm.; length of body in the series very uniform—males measuring from 30-32.4 mm., females from 32-34.5 mm.; females differ a little from males in having eye and tympanum slightly greater in size proportionally.

Color: In life ground color yellowish or olive-green with an indefinite dark triangular mark usually visible on head and occiput, the apex directed backwards; upper lip light without markings; legs barred; venter and chin without pigment, yellowish or whitish; dark pigment under thigh, tarsus, hand and foot; axilla yellowish or greenish yellow without dark pigment; some dark markings are usually present, and these consist of a pair of dorsolateral marks often accompanied by a median dark mark or stripe; frequently there are two longitudinal markings dorsolaterally.

Measurements in mm.: (of a female.) Snout to vent, 34.5; tympanum, 1.87; eye, 3.6; snout, 5.2; interorbital width, 3.2; head width, 11.4; head length, 12.8; leg, 54.5; arm, 21.5.

Remarks: A large series of a small species of frog taken at Turrialba, Costa Rica, is associated with *elaechroa* since they agree with the description and the type of this form better than with any other known species. One might imagine that a comparison with the type would settle the matter beyond question. However, the type is not in good condition, and some of the features are no longer distinguishable. Dr. G. K. Noble (*loc. cit.*) calls attention to some apparent discrepancies between the original description and the type.

Certain specimens, presumably of the species at hand, taken in Panamá by Dr. Emmett Reid Dunn, have been referred to *Hyla rubra*, but the characters of this latter species, larger size (reported 39-46 mm.), lateral light stripes with dark longitudinal markings and light spotting on front and back of thighs as well as certain other features, preclude the association of my specimens under that name. Whether the true *Hyla rubra* occurs in Panamá I cannot say.

The relationship of the species is with the small *Hyla staufferi* Cope described from Orizaba, Mexico. The enlarged choanae, reduction of the webbing of the hand, the almost complete freedom of the inner toe from web, the linear dorsal markings and triangular occipital marking, the elongation of the snout, the inconspicuous or absent canthus rostralis, the absence of both inner and outer tarsal folds, the absence of a fold or distinct tubercles on the forearm, the enlarged digital discs and the very prominent double palmar tubercle all point to close relationship.

Hyla staufferi has a wide distribution through southern Mexico. It has been reported in Honduras by Dunn and Emlen as *Hyla culex* Dunn and Emlen (*vide* Gaige and Stuart); from Nicaragua by Cope and presumably from Panamá, by Dunn as *Hyla altae* Dunn.

Hyla boulengeri, a much larger species that may be related has relatively much larger choanae, has the low elongate snout, the reduction of the finger web, and the inner toe practically free.

Hyla elaeochroa is represented in the collection by about 80 specimens. They were collected on a number of nights in June, July and August, 1947 and 1951. A few clasping pairs were taken. Females are few and may be readily recognized by their larger size, and being somewhat distended with eggs. The variation in pattern is considerable, the specimens varying from the typical five-lined pattern with the median dorsal line terminating in the triangular mark on the head, to individuals that show no trace of pattern whatsoever but are uniformly olive green or yellow green to gray above. The specimens lacking pattern were taken at night, but if these were examined the following day many of them would have developed the lineation. Later in the day the pattern might be very dark. Since most of my specimens were preserved shortly after capture at night, only a few show the pattern. There is no suggestion in the living specimens of reddish coloration, white spotting on the thighs or dorsolateral light stripes, all characters of *Hyla rubra*. The upper lip is slightly lighter than loreal region but there is no white or cream spot below eye; the dark line between nostril and eye continued back as a lateral line, is usually evident. The dorsolateral lines arise from back of eyelid, and the median line usually consists of a few median spots and a discrete triangular dark area, the apex of which is on the occiput. The expected marking on the thigh and legs is a single bar on thigh and three bars on the tibia. Pigment is absent from the ventral surfaces of the venter and chin, but part of the under surface of thigh, tarsus, hand and foot have considerable pigment. The axillary region is unpigmented.

Hyla staufferi Cope

Hyla staufferi ° Cope, Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 195 (type locality, Orizaba, Veracruz, "Obtained by Professor T. Sumichrast" probably a typographical error for F. Sumichrast); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études des Reptiles de l'Amérique

° In the type description of *Hyla staufferi* there is seemingly an error, the result of a *lapsus*:

The statement "vomarine teeth in fasciculi between nares, which are a little larger than choanae" obviously should read "vomarine teeth in fasciculi between choanae, which are a little larger than the fasciculi."

- Centrale, livr. 1, 1881, p. 36, pl. 14, fig. 3, 3a (Tapana, Tehuantepec, Mex., illustration good); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata, 2nd ed., 1882, pp. 400-401 (Mexico); Kellogg, U. S. Nat. Mus. Bull. No. 160, pp. 173-174 (Orizaba and Portrero, Veracruz); Smith and Taylor, U. S. Nat. Mus. Bull. No. 194, p. 88 (many localities in Mexico).
- Hyla eximia staufferi* Cope, U. S. Nat. Mus. Bull. No. 32, 1887, p. 14.
- Hyla eximia* (part.) Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1901, pp. 261-262; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 245 (part.).
- Hyla culex* Dunn and Emlen, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, 1932, pp. 24-25 (Tela, Honduras); Gaige, Carnegie Inst. Washington, Publ. No. 457, 1936, p. 293.
- Hyla altae* Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 8, 1933, pp. 61-62 (type locality, Summit, Canal Zone).

Diagnosis: Small frogs, (female 30 mm., male 27 mm.) with a low elongate snout, lacking a distinct canthus rostralis, the snout sloping very obliquely to lip in loreal region; diameter of tympanum one third to (more usually) one half eye length; toes, except inner, one-half to three-fifths webbed, bearing large terminal pads; fingers free, skin smooth or slightly tubercular; no inner or outer tarsal fold; choanae usually large, the vomerine tooth fasciculi between them, but smaller than choanae; usually a triangular interorbital bar or spot; with or without two to five irregular longitudinal dark stripes.

Description of species: Head oval, approximately as wide as body (except in gravid females); eye relatively small, much shorter than snout; snout flattened, the canthi very indistinct or absent, the loreal region but slightly concave, sloping obliquely to lip; area about nostril somewhat swollen with a slight, longitudinal depression between nostrils; anterior to nostrils, snout forms a somewhat pointed "nose", projecting beyond lip 1.3 mm.; tympanum distinct, directed slightly upward, its length 1.3 mm., its height 1.5 mm., separated from eye by a distance equal to its length; length of eye opening (2.75 mm.), about equal to its distance from nostril (2.7 mm.), shorter than length of snout (3.5 mm.); supratympanic fold indistinct; width of an eyelid (1.9 mm.) distinctly less than interorbital distance (2.7 mm.); distance between nostrils 1.85 mm.

Tongue rounding, a little longer than wide, not or scarcely emarginate behind, free only on posterior edge for one eighth its length; choanae large, the distance between them equivalent to 2.1 times the diameter of one; vomerine teeth in two small fasciculi between the middle of choanae, not reaching their posterior level, separated from choanae by a distance equal to length of one fasciculus and from each other by less than half this distance; choanae larger than openings of Eustachian tubes; vocal slits much elongated; a very large vocal sac extends from gular region to breast, where it is

limited by a distinct breast fold in males (the fold less distinct in females).

Arms short, the wrist not reaching tip of snout; a small axillary web; fingers unwebbed, their edges with very low ridges; digital discs large, increasing in size to third, which is 1.4 mm. in greatest width; inner metacarpal tubercles rather indistinct, at lower base of first finger; dorsal surface of first finger with a nuptial gland not reaching to end of the antepenultimate joint, without horny tubercles; palmar tubercle bifid, strongly defined; subarticular tubercles all single; glandular or tubercular ridge on under surface of arm all but obsolete.

Heel reaches middle of eye; when legs are folded at right angles to the body they overlap strongly (3.5 mm.), knee and elbow do not touch; between first and second toes the web greatly reduced forming a fringe on inner side of second; other toes from one half to three-fifths webbed, the web reaching to near disc of outer toe; no inner or outer tarsal fold; a small inner metatarsal tubercle, a smaller but distinct outer; largest toe discs equal to largest discs on fingers; supernumerary granules on foot and hand indistinct or obsolete.

Skin smooth with a few scattered small tubercles on loreal region, sides of body and back; arms and legs smooth; chin and breast smooth; venter and posterior part of the ventral face of femur granular; vent high without tubercles or granules in area.

Color: Above brownish, a little lighter on snout; triangular interorbital mark scarcely discernible; a dim dark streak from nostril to eye; a pair of curving lines from eyes across shoulders continued indistinctly on sides to sacrum; below this another indistinct darker irregular line on dorsolateral region; a few scattered small dark marks on rump; light line on lip with slight pigment, continuing on to side above arm; ventral surface of body and under surfaces of limbs creamy white or yellowish, bars on dorsal surface of tibia indistinct, those on femur obsolete; under side of hands and feet, except discs, pigmented.

Measurements in mm.: Snout to vent, 27; width of head, 8.9; length of head, 8.7; length of snout, 3.5; greatest diameter of tympanum, 1.6; length of eye, 2.75; arm, 14.2; hand, 7.2; leg, 36; tibia, 12.6; foot and tarsus, 16.5.

Remarks: Mrs. Helen T. Gaige, *loc. cit.*, has pointed out that *Hyla staufferi* is not closely related to *Hyla eximia*, but shows a close resemblance to *Hyla culex* and *Hyla altae*. She suggests that possibly Brocchi's figure, *loc. cit.*, may be *culex*.

In large series of specimens in the EHT-HMS collection of *staufferi*, one of the common species of Veracruz, specimens matching the figure given by Brocchi are common, and likewise specimens matching the descriptions of *culex* and *altae*.

The color pattern is extremely changeable. Specimens taken in the daytime are dark, strongly lined, with the interorbital bar strongly marked, and the barring on the femur strong on the dorsal surface, and extending somewhat on to the anterior face. Specimens taken at night are very light, often nearly yellow, with scarcely any evidence of marks. If these are preserved at night they retain the light color; if they are kept alive on into the following day, part or much of the normal pigmentation may reappear.

The presumed differences between *Hyla culex* and *Hyla staufferi* seem to be in the relative size of the tympanum and the eye. The statement "tympanum $\frac{1}{3}$ eye" leaves one in doubt as to whether the diameters or areas are being compared. The tympani of the greater number of specimens have their greatest diameter closely approaching one half the length of the eye opening; a few are a little less than this, approaching one third the length. I have not been able to examine the type of *culex*, but paratype No. 20262 in the Museum of Comparative Zoology is *Hyla staufferi* Cope. I have examined the type of *Hyla altae* in Harvard.

The inclusion of *Hyla staufferi* in the Costa Rican fauna is based on its presence in Honduras and Mexico and its presence in the Isthmus of Panamá. It is presumed that its lowland distribution is not discontinuous.

The type, U.S.N.M. No. 15317, has lost most of the original markings. The measurements are snout to vent, 25.5 mm.; transverse diameter of tympanum, 1.3 mm.; transverse diameter of eye, 2.4; eye to nostril, 3; head width, 8.5.

Hyla moraviaensis sp. nov.

Figure 57

Type: Kansas Univ. Mus. Nat. Hist. No. 30284, Moravia, Costa Rica (Caribbean drainage), Aug. 16, 1951, Edward H. Taylor, coll.

Paratypes: Nos. 30283, 30285, 30286, same locality, date, and collector.

Diagnosis: A small species (32 mm. ♂) with top of head convex, the eyes especially prominent; a tarsal fold; thighs strongly banded with black; arms, legs, and feet banded; brown above, strongly spotted; black on back and sides; venter largely pure white.

Description of type: Small frog (snout to vent 32 mm.); top of head convex rather than flat, its highest elevation between posterior part of orbits; eyes prominent, extending beyond outline of head; width of head at tympanum (11.8 mm.) greater than head length (9.2 mm.); width of head through eyes 12.5 mm.; diameter of tympanum (2 mm.) slightly greater than its distance from eye; length of eye 3.9 mm.; eye to nostril 2.6 mm.; median length of snout 2 mm.; canthus rostralis wanting; loreal region sloping gradually to lip; width of an eyelid (4 mm.) greater than interorbital width (3.5 mm.); area about nostrils slightly swollen, with a broad

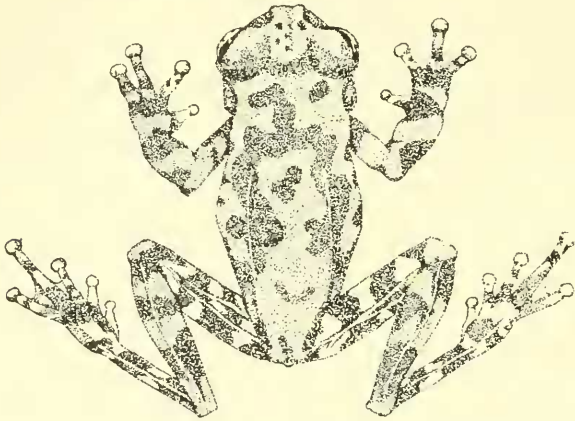


FIG. 57. *Hyla moraviaensis* sp. nov. Type. K.U. M.N.H. No. 30284; Moravia, Costa Rica; snout-to-vent length, 32 mm.

shallow depression between; tympanum directed partly outward and upward, the edges somewhat elevated; a narrow supratympanic fold, from eye, curving across top of tympanum to a point above arm; a very indistinct notch on upper lip; nostril nearly equidistant from eye and from median upper lip notch; tongue broadly oval, notched or indented behind, free for about one fifth its length; choanae rather small; vomerine teeth in two rounded elevated fasciculi between posterior part of choanae, separated from choanae and each other by equal distances; vocal slits elongate, the vocal sac indicated externally by folds.

Arm relatively long, with half of forearm extending beyond snout; terminal discs on fingers, except first, distinctly wider than digits, but smaller than tympanum; a web fringe between first and second fingers; outer toes a little more than one third webbed; distal sub-

articular pads of inner and outer fingers double; basal part of first fingers with a nuptial swelling, covered with minute blackish spines; a prominent palmar tubercle, bifid anteriorly; a slight fringe on outer finger and a row of rather indistinct tubercles on lower edge of arm.

Leg rather short, the heel reaching to the middle of eye; when legs are folded at right angles to body they touch or barely overlap; inner metatarsal tubercle distinct, the anterior edge free; inner tubercle not distinguishable; a distinct inner tarsal fold or ridge; terminal discs wider than digits, but on neither hand or foot are they as large as tympanum; toes more than three fourths webbed; a slight fold on outer edge of fifth toe continued as an irregular tubercular row on outer edge of tarsus.

Skin generally smooth with scattered soft pustules, indistinct or lacking on sides; chin and breast smooth, venter and under parts of thighs granular, those on thighs the larger; distinct tubercles on under side of hands and feet other than the subarticular tubercles; anal opening high, followed by an indistinct groove bordered by tubercles, larger than those adjoining; a slight axillary web.

Color: Above brown to lavender brown with numerous more or less rounded black spots or flecks; dorsolaterally and laterally lighter brown with larger black spots or blotches which low on sides are separated by yellow; a large area of yellow in groin; chin white, with a few black flecks; venter and under surface of arms, hands, feet, and thighs white, without dark markings; front, back and dorsum of thighs bright yellow bearing three deep black bands; a very indistinct brownish wash on dorsum of thigh, tibia lavender brown above with dim black marks dorsally becoming a deep black on edges and on under side; tarsus, foot and toes banded with black; arms, above, banded very indistinctly; a white spot borders lip below eye; rest of upper lip brownish white interrupted by 4 brown spots; black spots about nostrils and on each side of anal flap.

Measurements in mm.: Snout to vent, 32; length of head, 9.2; length of eye, 3.9; length of orbit, 4.2; length of snout (mesial), 2; arm, 20; leg, 45; tibia, 15.2; foot and tarsus, 20.5.

Remarks: The relationship of this species cannot be stated. I suspected at first that it might be referred to one of the three forms described by Cope from Pico Blanco, especially to *Hyla pictipes*. These three forms, originally considered as subspecies of *Hyla punctariola* are very inadequately described. *Hyla punctariola* has been shown to belong to *Eleutherodactylus*, but it is presumed that the three forms are really members of the genus *Hyla*.

Cope describes *Hyla pictipes* as light brown above, not sharply bordered on the sides. Below white; edge of lip, tarsus, and outer toe, white. The sides are marbled with dark brown and yellow from near axilla to groin; and the front and back of the femora on each side of the superior brown longitudinal band are yellowish-brown spotted with bright yellow; two outer toes brown, inner toes yellow; humerus, cubitus and two outer fingers brown above. Back, lips, and belly unspotted. Two cotypes are known.

Three specimens were taken on weeds bordering a small roadside ditch; one was taken in forest on a plant growing in a small rivulet. Numerous specimens were heard calling from a tiny spring-fed rivulet, but none were found since the calls ceased when one approached.

The species is named for the great finca of Moravia. The genial owner, Sr. Don Fernando Alvarado Chacon, to whom I am greatly indebted, permitted me to collect there, and provided me with excellent quarters. For this I am deeply grateful.

Hyla loquax Gaige and Stuart

Figure 58

Hyla loquax Gaige and Stuart, Occ. Papers Mus. Zool. Univ. Michigan, No. 281, 1934, pp. 1-3 (Ixpuc Aguada, north of La Libertad, El Petén, Guatemala); Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, p. 587 (Piedras Negras, Guatemala); Taylor, Amer. Mus. Novitates, No. 1473, Dec. 7, 1949, p. 12 (Río Chicapa, Oaxaca).

?*Hyla stadelmani* Schmidt, Proc. Biol. Soc. Washington, vol. 49, 1936, p. 45 (Subirana Valley, 2800 ft. altitude, Yoro, Honduras).

Diagnosis: Medium-sized frogs, the adult males measuring from 37-45 mm. snout to vent; an extensive axillary web; a fold across the breast; fingers about one fifth, toes fully, webbed; a distinct inner glandular tarsal fold present; heels of adpressed limb reaches to eye; heels do not overlap when legs are folded at right angles to body; vocal sac large, limited by breast fold; choanae distinctly smaller than the raised vomerine tooth fasciculi, which are separated from choanae by a distance nearly twice that between the fasciculi; legs, on concealed surfaces, and groin, reddish or reddish orange.

Description of species: (K.U.M.N.H. No. 24614; Turrialba, C. R.) Medium-sized hylas (snout-to-vent length of males and females about equal); head usually not as wide as body; width of head (15 mm.) nearly same as head length (14.8 mm.); orbits but little elevated; regions about nostrils very slightly swollen, with a slight depression between them; tympanum distinct (2.1 mm. long and 2.3 mm. high) bordered by a slightly elevated rim; separated from the eye by a distance equal to its length; eye length, 4

mm. the posterior section of lid slightly separated, its edge nearly vertical; width of eyelid in interorbital interval one and two-thirds times; no canthus; distance between eye and nostril, 3.7.; from nostril to the median indefinite notch in upper lip, 3.4 mm.; loreal region not concave, sloping obliquely to lip; length of snout, 4.3 mm.; the tip extending beyond lip 1.2 mm.

Tongue subcircular, only posterior edge free; vocal sacs very large, the vocal slits elongate, opening just inside of jaw edge; choanae small, lateral, separated by a distance of 4.5 mm.; vomerine teeth in two fasciculi, each about size of a choana situated between choanae but extending anterior to their anterior level and not reaching their posterior level, closer to each other than to choanae;



FIG. 58. *Hyla loquax* Gaige and Stuart. K.U.M.N.H. No. 29609; Turrialba, Costa Rica; snout-to-vent length, approx. 42 mm.

openings of palatal glands in a continuous, nearly straight groove a little closer to tooth fasciculi than to front of palate.

Skin finely corrugated with indications of a very few lateral pustules; sides slightly wrinkled, venter and much of the ventral face of thigh covered with strong granules; a short anal flap; vent high followed by a groove flanked with numerous granules; skin leathery, on back largely underlain by a layer of pure white glandular tissue; a very ample vocal sac visible externally; a fold from eye overhanging tympanum is continued on side for some distance.

Arm short, the wrist barely extending beyond snout tip; fingers with broad terminal discs, those of outer fingers equal or slightly larger than tympanum; inner finger less than one-third webbed; nearly two-thirds webbed between second and third and third and fourth, the webs reaching most of the discs as narrow fringes; subarticular tubercles all single; numerous granules on palm; palmar tubercle rather indistinct, small; metacarpal tubercle large, widening base of first finger; latter surmounted by a nuptial swelling covered with small asperities but not horn covered (at this time of the year at least); an indistinct row of tubercles under forearm; a well-developed axillary web attaching to outer third of humerus.

Leg short, the heel reaching near front edge of eye; toes four fifths to fully webbed, the webs reaching discs of toes except fourth; a small inner metatarsal tubercle; an inner tarsal fold present; a fringe on outer toe continued more or less on tarsus as an outer tarsal fold or ridge; web and under side of toes with irregular granules; discs on toes smaller than those on fingers.

Color: Generally brownish or dark brown above with some fine indefinite scattering of darker pigment; wide area in groin, posterior face of thigh, tibia and part of foot reddish to reddish orange; venter, lower part of sides (anteriorly) under arms, chin and throat canary to lemon yellow; under side of tarsus and much of foot with dark brown pigment.

Measurements in mm.: Snout to vent, 42; width of head, 15; length of head, 14.8; length of snout, 4.3; length of eye, 4; arm, 27; hand, 13; leg, 63; tibia, 21; foot and tarsus, 29.

Variation: Dorsally, color generally red or orange brown; some slight scattered darker pigment, with numerous small black dots or with a rather large hourglass pattern on the head and shoulders. A few specimens are somewhat olive in color. In life the olive color is rather prevalent at night but in daylight this assumes a reddish orange-brown color and the dark pattern becomes more or less

evident; color of sides, venter, throat, chin and underside of limbs and thigh, canary to lemon-yellow. The groin, sides of thigh, tibia and part of foot reddish or reddish orange or orange. This color does not disappear in preservative for many months, in which case the entire concealed surfaces become whitish in color. In a few specimens there is only a broad pigmented stripe across the dorsal surface of thigh but in others there may be only scattered pigment present.

Remarks: A series of thirty-two specimens taken at various times during the summer from an artificial pond at the Inter-American Institute of Agriculture at Turrialba, Costa Rica, have been referred to this species, that was originally described from El Petén, Guatemala. Specimens have been taken as far north as southern Oaxaca. I have examined the types of *Hyla stadelmani* from Honduras and I believe this represents the same species. I have not directly compared them with the type of *loquax* but any differences that might be noted when compared with a paratype could be regarded only as of subspecific value, if that. The original description of *loquax* fails to mention the extensive axillary webs which attach far out on the outer third of the upper arm.

Only one pair was found clasping (June 24). They were heard at night throughout the summer at such times as I was in the neighborhood of the pond until I left, September 15. I suspect that they called every night. The specimens were perched on reeds and papyrus growing in or on the edge of the water and were usually perched one to four feet above the water level. Their loud harsh "quacks" make one suspect that they are well named.

In 1951 I found the species at Moravia (south of Turrialba). Here the species was calling from the lotus leaves floating on a small pond. The calling continued all night long, occasional calls being heard in the daytime.

Hyla pseudopuma Günther

Figures 59, 60

Hyla puma Boulenger, Proc. Zool. Soc. London, 1898, p. 478 (*non* Cope).

Hyla pseudopuma Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, pp. 274-275, pl. 72, figs. A and B (type locality, La Palma, Costa Rica, 1600 m. alt. Specimens from the Museo Nacional de Costa Rica); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 254.

Diagnosis: A medium sized species, female reaching a length of 46 mm.; nostril nearly equidistant from eye and from median notch in upper lip, or slightly closer to eye, the snout in lateral profile sloping obliquely to lip; canthus distinct, rounded; greatest diameter

of tympanum equal to three fourths the length of the eye; latter relatively small; supratympanic fold curves down strongly behind angle of jaw; distal subarticular tubercles of all fingers double or bifid; toes between two thirds and three fourths webbed; chin and belly whitish, or with some darker pigment; some white spots or flecks along the lower edge of the darker coloration of sides; an hourglass-shaped figure may be present on back.

Description of species: (from MCZ No. 15308, Barba, Costa Rica.) Head as broad as body, its width (16 mm.) greater than its



FIG. 59. *Hyla pseudopuma* Günther. Copied from Günther, Biologia Centrali-Americana, Reptilia and Batrachia, pl. 72, fig. A; La Palma, Costa Rica; snout-to-vent length, approximately 40 mm.

length (14 mm.); canthus distinct, slightly rounded; upper part of lores nearly vertical, lower part sloping obliquely to lip; top of snout nearly plane, the swelling about nostrils not strongly developed; tympanum diagonally oval, its upper part concealed by supratympanic fold, its greatest diameter (3 mm.) greater than the length (2.8 mm.), its distance from eye (2 mm.) much less than its diameter; eye relatively small, the length of the opening (3.9 mm.) equal to its distance from nostril, but less than the length of snout (6

mm.); upper eyelid (3 mm.) much less than interorbital width (4.4 mm.); snout tip, in profile, sloping downward toward lip, the lower part rounded; a strong fold from eye curves across top of tympanum and down close behind angle of jaw.

Choanae relatively small, diameter of one in distance between them nearly six times; vomerine teeth in two fasciculi between posterior part of choanae, but tooth rows usually behind posterior level of choanae, separated mesially from each other by a distance one fourth length of a fasciculus from choanae by a little more than half the length of one; tongue broadly cordiform or rounded in front, narrowly notched behind, a little wider than long, not or scarcely free behind; males with elongate vocal slits; openings of palatal glands in a sinuous line, nearer end of palate than anterior level of choanae.

Arms short, moderately thick (more especially so in males) the musculature tending to hold the arms fixed and flexed at right angles, making it difficult to straighten them without breaking muscles; a small but indistinct axillary web. A vestige of a web between inner fingers; second finger with the web two fifths of its length with a broad fringe that reaches disc while on fourth finger the fringe is very narrow; outer fingers two-fifths webbed, the fringes narrow; outer metacarpal tubercle large, compressed, the palmar tubercle rather indistinct, tripartite; a more or less distinct line of rounded tubercles on under surface of arm; distal subarticular tubercles of fingers all double or strongly bifid (occasionally single on second finger); heel reaches to nostril or tip of snout; knee and elbow barely overlap when adpressed on body; an inner metatarsal fold present; inner metatarsal tubercle small, outer very small but distinct; toes four fifths webbed, webs on toes reaching to disc on second, third and fifth, but somewhat excised between them; first toe about half webbed, others two fifths to three fourths webbed; discs of fingers a little less than size of tympanum; toe discs distinctly smaller; when legs are folded at right angles to body, heels overlap four millimeters.

Skin on dorsum generally smooth (sometimes with scattered fine tubercles dorsolaterally); on sides skin wrinkled, and broken into fine elongate folds; chin and breast rather indistinctly granular the granules scattered; venter strongly granular, under side of femur with granules, a few on the posterior part enlarged somewhat and elevated; anal flap moderately elongate, the vent high; a groove following vent flanked by granules.

Color in preservative: Markings generally gray brown, the snout

brownish; a large lighter-centered black-edged spot beginning between eyes, the posterior outline forming a curve; two convex curved lines on middle of back; almost entire surface of back with very numerous minute black flecks; arm and leg banded with dusky; side of body dark blackish, with several small cream spots more numerous in groin; ventral surface generally light with a few brownish flecks on a whitish chin; front and back surfaces of femur strongly pigmented; lateral dark coloration of side encroaching on sides of neck. Under surface of the tarsus strongly black flecked. (Frequently the markings are in the shape of an hourglass beginning between the eyes and extending to the rump. Occasionally specimens lack dorsal markings and are grayish white on the back, or dark gray to brown.)

Colors given in the type description are "plum-colored," the "concealed surfaces of the femur uniform dark, like back, but without spots. Lower parts white, throat speckled brown. The groin where the two colors meet shows some marbling or spotting. Another variety has a grayish or white back; a broad deep brown fascia on the side of the body starts from the eye and tympanum, and is variegated with more or less numerous yellow spots along its lower margin."

Measurements in mm.: Snout to vent, 43; length of head, 14; width of head, 16; length of eye, 3.9; diameter of tympanum, 3; length of snout, 6; arm, 29; hand, 13.5; leg, 71; tibia, 23.5; foot and tarsus, 13.

Remarks: Males have the dorsal surface of the base of the first finger with a nuptial swelling covered with numerous blackish spines. The penultimate joint is about one third covered.

One young male from Barba, C. R. in MCZ, under a lens shows the skin corrugated on the hand, and the canthus is slightly angular.

The species is known in Costa Rica from La Palma, La Estrella, Volcán Barba, Volcán Poás, and Moravia. It has also been reported from Panamá.

Four specimens from Volcán Barba are dark black-brown above with dark pigment spots on chin (Nos. 30179-30182). In a series (Nos. 30183-30190) taken at approximately 6800 feet on the western slope of Volcán Poás, males are gray olive above with a slightly darker lateral band on which some lighter marks are evident. The females are larger, darker lavender or brown above with the hourglass marking either present or absent.

Two specimens, a male (No. 30191) and a female (No. 30192) taken at Moravia are referred here with some reluctance. The

male has the nostril much nearer the eye than the lip (the female slightly so), the snout being pointed; the dark olive lateral stripe begins behind the eye and extends to groin and bears several discrete cream or cream yellow spots. The female does not show the lateral stripe distinctly but the cream yellow spots are present. There is a triangular dark mark on the head and a large quadrangular dim dark mark on middle of the back. There are a few



FIG. 60. *Hyla pseudopuma* Günther. K.U.M.N.H. No. 28199 ♂; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 43 mm. (This specimen differs somewhat from Günther's figure given with the type description, pl. 72, figs. A and B.)

small rounded black spots on back and head. The general habitus suggests *pseudopuma*. The male when first taken secreted a slimy fluid that when placed in a little water tended to make the water sirupy in consistency. I have not noticed this secretion on the typical specimens of Barba.

Specimens, except for the last two mentioned, were taken in bromelias during the day. They varied much in color from blackish to yellow but in captivity they all became nearly a uniform olive above, after a time. The lot from Barba again darkened when kept in a sack overnight.

Hyla zeteki Gaige

Figure 61

Hyla zeteki Gaige, Occ. Papers Mus. Zool. Univ. Michigan, No. 207, Sept. 28, 1929, pp. 4-6 (type locality, Caldera Valley above Boquete, Chiriqui Province, Panamá; H. T. Gaige, coll.); Dunn, Copeia, 1937, pp. 164-167.

Diagnosis: A diminutive hylid with a distinct tympanum facing more upward than outward, its diameter approximately one third the length of eye; snout very short, canthus absent or indistinct, rounded, curving forward, the loreal region strongly concave; nostrils nearly terminal; outer fingers less than one-third webbed; outer toes about two-fifths webbed; inner less than one-fourth webbed; a pair of elongate, strongly elevated tubercles below vent curving



FIG. 61. *Hyla zeteki* Gaige. K.U.M.N.H. No. 28183 ♀; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 25 mm.

under thigh; finger discs much larger than tympanum; sides with flat granules; red marking usually present on back, and spectacle-like marks surrounding eyes; arm strongly covered on front and ventral side with tubercles or granules.

Description of the species: (From K.U.M.N.H. No. 28183, Isla Bonita, C. R. ♀.) Head broader than body, the eyes large, protuberant, directed somewhat forward; width of head (8 mm.), minutely greater than length of head (7.9 mm.); canthus rostralis very indistinct, rounded on edge, and strongly curved from eye to nostril; the nostrils nearly terminal, tip of snout blunt, its profile nearly vertical, extending but slightly beyond the mouth; areas about nos-

trils slightly swollen, with an indistinct depression behind and between them; loreal region concave; lores nearly vertical on upper part then sloping obliquely to lip; a fold from eye above tympanum curves somewhat inward, permitting back part of the jaw to be seen from above; tympanum distinct, directed obliquely upward, somewhat elevated, strongly pigmented, its upper edge covered by the fold, its diameter (.9 mm.) a little less than one third length of eye (3 mm.); the distance between tympanum and eye a little more than twice diameter of tympanum; length of eye (3 mm.) considerable greater than length of snout (2.65 mm.); width of an eyelid (2.1 mm.) less than interorbital distance (3 mm.); distance between nostrils 1.7 mm.

Choanae moderate, diameter of one (.4 mm.) contained in the distance between them, five times; vomerine teeth in two fasciculi somewhat diagonally arranged between posterior part of choanae but extending some distance behind their posterior level, each fasciculus as large as or larger than a choana, separated from each other by a distance of little less than their distance from choanae. Palatal glands opening through a series of separate pores, the series curving back to near the anterior level of choanae; tongue very large, flat, its width (5 mm.) greater than its length (4.7 mm.) free for less than one fourth of its length, the maxillary shelf continuous, concealing front part of palate when seen from below; openings of the Eustachian tubes nearly as large as choanae.

Arm short, slender, the wrist barely reaching tip of snout; inner fingers with only a trace of web; the two outer about one-third webbed; discs large (1.3 mm.), much wider than the digits; distal subarticular tubercles on all fingers double or bifid; a large inner metacarpal tubercle; outer palmar tubercle tripartite moderately distinct; surface of palm and fingers covered with strong granules; a row of flat indistinct tubercles under arm. Leg short, the heel reaching to front level of eye; between two inner toes only a vestige of a web; between second and third, one-third webbed; between outer toes about two-fifths webbed; narrow fringes reaching the discs on all toes; a strong but short inner metatarsal tubercle; a small indistinct outer tubercle, scarcely distinguishable from small granules covering foot; no distinct tarsal fold but the surface indistinctly granular and toward heel some elevated tubercles.

Skin of head smooth; under lens dorsal surface of body and to a lesser extent the legs, finely corrugated; sides, beginning at tympanum, finely granular as are chin and breast; *under surface of arm*, as well as breast and venter, strongly granular; under surface

of thigh almost entirely covered with larger granules, irregular in size, and with two large elongate elevated tubercles below vent, separated by granules; vent near upper level of thigh with a short flap; skin in groin and on front and back of thigh relatively smooth.

Color in life: Head brownish olive; dorsal surface dull lemon; below, on belly, sides, and on limbs, flesh white; eyes dark; a yellow line from nostril to eye bordered above and below by darker.

In preservative the color is slightly lavender-tan, the pigment very sparse; some distinct darker spots on top of snout; a dark line along upper loreal region and a lighter area on the eyelid is outlined by darker pigment, the light area itself is crossed by some indistinct darker stripes; another from below nostril to eye, the two separated by a light line; eyelids dark.

Measurements in mm.: Snout to vent, 25; head width, 8; head length, 7.9; eye length, 3; diameter of tympanum, .9; interorbital distance, 3; length of snout, 2.65; arm, 14; hand, 7.2; leg, 38; tibia, 14; foot and tarsus, 18.2.

Remarks: This small species was obtained from bromelias at night. Its relationship is obscure since the characters of the male are as yet unknown.

The specimen differs but little in color and marking from the type description. No median red streak was present or red in the other coloration. The black "spectacle-like" markings around eyes meeting mesially are not clearly defined; the eye is distinctly longer than snout, the toe discs smaller than finger discs.

Hyla picadoi may be distinguished from it by the concealed tympanum, the strong glandular area in the temporal region, the distinct "nose", and the two toothlike projections in the lower jaw.

The Costa Rican specimens of *Hyla zeteki* referred to by Dunn (*loc. cit.*) differ from the type in the absence of the red dorsal marks as well as the peculiar head markings. The type series also has certain specimens in which the markings are largely absent.

My specimen was taken from a bromelia along with *Eleutherodactylus diastema* and was not recognized in the field. The locality is Isla Bonita, eastern slope of Volcán Poás, at an elevation of approximately 5500 ft.

Hyla pictipes Cope

Hyla punctariola pictipes Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875 p. 106 (type locality, Cordilleras, 5000-7000 ft. on Pico Blanco, Costa Rica; Wm. Gabb coll.)

Hyla punctariola Boulenger, Catalogue of the Batrachia Saliientia s. Ecaudata in the Collection of the British Museum, 2nd ed. 1882, p. 401 (*part.*); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 256-257, (*part.*).

Diagnosis: This hyla may be distinguished by the following characters: Small hyla (male 26 mm. female 29 mm.) snout to vent; first finger with scarcely a trace of web; between second and third fingers, one third webbed; between outer fingers one fourth webbed. Width of choana in distance between choanae, three times; tongue free for about one fifth of its length. Sides with broad light area enclosing darker spots; groin dark enclosing white or cream spots; white spots on front and back of thigh.

Description of type: The type specimens are old and much softened and many of the characters of this poorly described species cannot be determined by examination.

Head moderately wide (9.9 mm.) slightly greater than length (9.5 mm.); tympanum small, .8 mm. in diameter a little less than one third of the eye length (2.6 mm.); distance between eye and nostril (2.1 mm.) less than eye length; loreal region concave; nostrils nearly terminal; upper part of tympanum partly concealed by the supratympanic fold.

Choanae rather large the width of one (.8 mm.) in the distance between them (2.5 mm.) three times; vomerine teeth in two small groups between but extending behind posterior level of choanae. Tongue as wide as long (5.5 x 5.5 mm.) free for more than one fifth of its length; vocal slits large; openings of the Eustachian tubes equally as large as choanae.

Arm moderate; scarcely a trace of web between first two fingers; between the second and third, approximately one third webbed; between the two outer fingers, a little more than one fourth webbed; outer finger with a bifid subarticular tubercle; leg moderately long, the heel reaches to the nostril; the two inner and two outer toes approximately half webbed; between inner toes, two thirds webbed; an axillary web present.

Color: Light brown above, not sharply bordered on the sides; ventral surfaces white; edge of upper lip, tarsus, and outer toe white; sides marbled with dark brown and yellow from near axilla to groin; the front of thigh dark brown with four or five bright yellow spots; back of thigh dark with irregular yellow spots, the spots small and scattered; under side of tibia with white or yellow spots; a light line along outer edge of foot; anal opening high on thigh, the area about vent with some white color.

Measurements in mm. of cotypes Nos. 30652 ♂ and 30631 ♀: Snout to vent, 26, 29; width of head, 9.9, —; length of head, 9.5, —; length of eye, 2.6, —; tympanum (diameter) .8, —; arm, 17, —; hand, 8, —; leg, 43, 52; tibia, 15, 16; foot and tarsus, 18, 22.5.

Remarks: In No. 30631, the brown of the back and the light color of the sides tend to dovetail. There is a pair of subanal tubercles colored white. The groin is dark with discrete yellow spots.

Compared with *moraviaensis* the head is proportionately longer, 9.9 wide by 9.5 long (in *moraviaensis*, 11.8 by 9.2); lip white in *pictipes*, with four strongly defined black brown spots, separated by lighter areas in *moraviaensis*; heel reaches to nostril in *pictipes*, to middle of eye in *moraviaensis*. The eyes are more prominent and the dorsal coloration is different.

Hyla debilis sp. nov.

Figure 62

Type: K.U.M.N.H. No. 28184. Isla Bonita, (American Cinchona Plantation) eastern slope Volcán Poás, 5600 ft., August 1, 1947; Richard C. Taylor and Edward H. Taylor, collectors.

Paratype: R.C.T. No. 786; same locality and data.

Diagnosis: A diminutive species 26.2 mm. snout to vent; a moderately sharp curving canthus, the snout subtruncate, the sides vertical, in profile snout pushing out strongly beyond lip; tympanum half the length of eye opening, separated from eye by less than its diameter; outer finger only with distal subarticular tubercle double; uniform olive above with a single narrow elongate white glandular spot on side beginning near middle and reaching near or to the groin; a long light spot on lip at base of snout, another below eye; venter light flesh without dark flecks.

Description of type: Head length (8 mm.) greater than its width (7.5 mm.); eyes strongly flaring out; snout short subtruncate; canthi slightly rounded, curving to above nostrils; loreal region nearly vertical, not or but slightly concave; tip of snout extends nearly 2 mm. beyond lip, the nostrils nearly terminal; top of head flat, not depressed, the area about nostrils not or scarcely swollen; tympanum distinct, longer than high, not covered by skin, its surface shiny, its upper edge concealed by a supratympanic fold which runs diagonally from eye to above arm and continues as a free fold to groin; diameter (length) of the tympanum (1.85 mm.) a little greater than its distance from eye (1.6 mm.); length of eye opening (3.1 mm.) greater than snout length (2.3 mm.); nostril closer to eye than to the median point of upper lip; width of an eyelid (2.3 mm.) less than interorbital distance (3 mm.).

Choanae moderate, somewhat lateral, the inner edges straight, the diameter of one in distance between them 2.8 times; vomerine teeth in two almost contiguous fasciculi between the posterior part

of choanae but extending much beyond their posterior level; separated from choanae by less than half width of one fasciculus; tongue as long as wide, slightly emarginate behind; one sixth free behind; vocal slits elongate, considerably mesial from edge of mandible; an external vocal sac indicated.

Wrist extends considerably beyond tip of snout; axillary web small but distinct; first finger very small, with a vague web remnant; second more than one fourth webbed with a broad fringe on the outer edge to disc; outer fingers half webbed; fourth finger with a



FIG. 62. *Hyla debilis* sp. nov. K.U.M.N.H. No. 28184, Type; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 26.2 mm.

distal subarticular tubercle double; diameter of largest finger disc 1.3 mm.; that of first finger .6 mm.; inner metacarpal tubercle large, partly covered by a swollen nuptial gland, which covers part of base of first finger but does not reach penultimate joint; palmar tubercle quadripartite, scarcely distinguishable from granules of hand.

Heel reaches to behind middle of eye; no inner or outer metatarsal fold; inner tubercle small, outer still smaller, flat; inner toes one third webbed; outer toes a little more than half webbed; discs of toes not or but slightly smaller than finger discs; heel and elbow overlap on side; when legs are folded the heels overlap .5 mm.

Skin glassy smooth, under lens minute pores visible. Chin, throat,

and breast smooth without a breast fold; venter, part of sides, part of under side of femur strongly granular; vent high, followed by a small groove flanked on each side by a flat tubercle; each of these in turn touching a much larger flat tubercle lying lateral to and partly behind it.

Color: Dorsally, uniform dark olive on back, top and sides of head; tympanum lighter, somewhat brownish; a bandlike light spot extends around snout on edge of upper lip, highest in front; this separated completely from an elongate white spot below eye and entering orbit; a white spot on sides in lumbar region extending nearly to groin bordered below by olive; arms and limbs yellow-olive; above yellowish flesh on concealed parts; front of femur pigmentless as is the greater part of the posterior surface; under surface of foot pigmented; hand without pigment; no ventral flecks.

Measurements of type and paratype respectively (in mm.): Snout to vent, 26.2, 26; width of head, 7.5, 7.3; length of head, 8.8; length of tympanum, 1.85, 1.65; length of eye, 3.1, 2.9; length of snout, 2.3, 2.3; arm, 27, 26.8; hand, 7, 6.8; leg, 37.2, 38; tibia, 12, 12.4; foot and tarsus, 17.4, 16.7.

Variation: The paratype has minute brown spinules on the nuptial swellings suggesting sexual maturity (visible under a lens), and the skin is shown to have minute corrugations in both specimens. The lateral spot shows the presence of minute skin glandules suggesting that the spot is actually an indistinct lumbar gland. In the paratype there is an indistinct unpigmented line above outer side of the tarsus and a suggestion of an outer tarsal fold.

Remarks: This form, occurring as it does in the same general area with *Hyla rivularis*, might be mistaken for it, since the snout overhangs the lip, the loreal region is nearly vertical, and the vomerine teeth have the same relative position. The presence of the lumbar glandular spot, absence of ventral spotting, the white markings on the head, and the large distinct tympanum amply separate the forms. It is seemingly a smaller species. There is likewise a marked difference in the call.

Specimens were found at night by tracing their feeble calls to plants growing in a small stream. In the same general region specimens of the rare *Phyllomedusa lemur* were taken by Richard Taylor.

Hyla alvaradoi sp. nov.

Figure 63

Type: Kansas University Mus. Nat. History, No. 30886; collected at Moravia, Costa Rica (on the Caribbean Slope), Aug. 16, 1951, by Edward H. Taylor.

Diagnosis: A small hyla, snout to vent, 32 mm.; terminal digital discs of fingers equal, but not wider than digits; those on toes somewhat narrower than digits; tympanum more or less distinct, covered with skin, and separated from eye by a distance greater than its diameter; top of head flat, without obvious swelling about nostrils; outer fingers less than one third webbed, toes a little more than four fifths webbed; inner tarsal fold rather indistinct on mesial ventral part of tarsus; tibiotarsal articulation reaches anterior edge of eye; fasciculi of vomerine teeth between posterior part of choanae, their outer ends extending somewhat behind choanae, the teeth



FIG. 63. *Hyla alvaradoi* sp. nov. Type. K.U.M.N.H. No. 30886; Moravia, Costa Rica; actual snout-to-vent length, 32 mm.

rows arranged in a broad V shape. Cream yellow in life with a white line from behind eye to a point above arm; skin minutely corrugated with a very sparse scattering of pigment.

Description of type: Head flat, the snout not extending beyond lip; canthus distinct, slightly rounded, forming nearly a straight line between eye and nostril; area about nostril only slightly swollen, the loreal region somewhat concave, the upper part nearly vertical, the lower sloping rather abruptly to lip; a fold from eye to a point somewhat beyond back level of arm insertion, covering upper edge of tympanum; latter covered with skin, but evident, its greatest diameter (1.5 mm.) less than half length of eye (3.85 mm.); dis-

tance from eye to nostril (3 mm.) about equal to median snout length (3.1 mm.); width of head (12 mm.) equal to head length; eyes not prominent, not or but slightly elevated, the width of an eyelid (2 mm.) in interorbital interval, 2.5 times; choanae relatively large, the diameter of one in distance between, about 3.2 times; vomerine teeth in two rather high fasciculi, situated between posterior half of choanae but extending behind them, the teeth forming a broad, inverted V-shaped series separated mesially by a distance equal to a third of length of a fasciculus, and from choanae by a distance a little more than half length of a fasciculus; tongue relatively small, subcircular, slightly longer than wide; vocal slits at some distance from jaw bones, largely lying behind tongue; openings of Eustachian tubes distinctly smaller than choanae; vocal sac can scarcely be discerned externally; the gland on the tip of chin large, rather prominent.

Arm with wrist reaching considerably beyond tip of snout; fingers short, the second a little longer than first, the terminal pads not wider than digits; merest remnant of web between first and second fingers; between second and third, the web about one fourth length of second finger; between third and fourth, about one third webbed; a thickened ridge under arm but without tubercles or a fold; large metacarpal tubercle showing no trace of nuptial swelling or nuptial asperities; subarticular tubercles small, single, other tubercles indistinct or obsolete; toes tapering slightly, the terminal discs not as wide as digits; toes three fourths webbed (or a little more); inner metatarsal tubercle indistinct, not or but slightly elevated; outer tubercle presumably absent; inner tarsal fold may be represented by an indistinct thickened mesial ridge on underside of tarsus; tibiotarsal articulation to anterior part of eye; legs folded at right angles to body, the heels touch or barely overlap; no dorsal folds except a supratympanic fold that crosses the shoulder; a pair of folds arising in front of arms and continuing back diagonally on thighs for some distance; a distinct groove below vent; skin practically smooth (under a lens very finely corrugated); venter and under side of thigh with somewhat flattened granules. A very slight axillary web present.

Color in life: Dorsum greenish yellow, the yellow color predominating; hands and feet yellowish; legs yellowish with a slight greenish wash on toe pads but not under fingers; a cream-yellow line from eye back on shoulder; venter cream; under legs flesh with a slight yellow tinge; vocal sacs seemingly paired; a whitish glandular area on tip of chin; sides yellow cream, nearly uniform with a slight

brownish wash dorsolaterally; an orchid yellow line borders the anal flap.

In preservative the yellow has disappeared leaving the creature white but with a sparse peppering of fine black pigment with occasional larger spread chromatophores, and a scattering of minute rounded cream dots on the dorsal surfaces; iris mixed shades of brown; pupil a narrow horizontal slit. The muscles appear whitish below skin.

Measurements in mm.: Snout to vent, 32; width of head, 12; length of head, 12; diameter of tympanum, 1.5; length of eye, 3.85; arm, 21; leg, 55; tibia, 18.5; foot and tarsus, 25.5.

Remarks: I am unable to discover the relationship of this species. The character of the pigment suggests a similarity to *Cochranella* and *Centrolene*, but the astragalus and calcaneum are not fused. It may be a relative of *Hyla wilsoniana* Cope.

The specimen was captured at night on a green plant growing on the edge of a small forest rivulet. In the same immediate locality specimens of *Hyla rufoculis*, *Hyla moraviaensis* and *Cochranella talamancae* were also taken.

Hyla ebraccata Cope

Figure 63a

Hyla ebraccata Cope, Proc. Acad. Nat. Sci. Philadelphia, 1874, p. 69 (type locality, Nicaragua, John F. Bransford coll.); Brocchi, Mission Scientifique au Mexique . . . ; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 44; Taylor and Smith, Proc. U. S. Nat. Mus. vol. 95, 1945, p. 587, fig. 60 H.

Hyla leucophyllata Taylor, Univ. Kansas Sci. Bull., vol. 28, 1942, p. 30.

After an examination of certain specimens in eastern Museums labeled *Hyla leucophyllata* Beiris, from Central and South American localities, I am forced to conclude that more than a single species is involved. This, despite the fact that certain forms already described have been thrown back into synonymy. At the moment it is impossible for me to determine which form should bear the name *leucophyllata*. I feel reasonably certain that it does not apply to the form occurring in Central America. Hence I am following Taylor and Smith (*loc. cit.*) in the use of Cope's name, *ebraccata*.

Diagnosis: This species may be diagnosed as follows: diminutive frogs (males 27 mm., females 32 mm. in snout-to-vent length); snout short, rather blunt, the loreal region nearly vertical; outer fingers between one half and two thirds webbed; toes four fifths webbed. A strong tarsal fold and strong axillary web; a band of darker pigment from snout to groin, often merging with the darker dorsal

marks; a dark triangular figure beginning between eyes often continuous with a large irregular spot on middle of back, sometimes together forming an hourglass figure.

Description of species: (K.U.M.N.H. No. 24694 ♀, Turrialba, C. R.) Head width (10.1 mm.) a little greater than length of head (9.2 mm.); canthus distinct, rounded, strongly curving to nostril, the lores nearly vertical in the upper part, lower part slop-



FIG. 63a. *Hyla ebraccata* Cope. K.U.M.N.H. No. 24728; Turrialba, Costa Rica; actual snout-to-vent length, 28 mm.

ing obliquely to lip, not concave; nostrils nearly terminal, with but slight swelling about them, and none or a very insignificant depression between them; surface of snout depressed, the interorbital area slightly elevated; tympanum distinct, circular, directed outward and slightly upward, heavily pigmented, its diameter 1.3 mm., separated from eye by 1.9 mm.; length of eye (3.2 mm.) about equal to length of snout (3.25 mm.); distance between nostrils equals their distance from eyes; nostril equidistant from eye and median notch in upper lip; width of an eyelid (2.2 mm.) distinctly less than the interorbital width (3.4 mm.); the supratympanic fold runs straight back above the tympanum, then curves abruptly down toward the arm inser-

tion; posterior line of border of eye slightly lobulate; choanae large rather lateral, the width of one (.8 mm.) contained in distance between them (3 mm.) a little less than four times; vomerine teeth in two small fasciculi equally distant from each other as from choanae, and lying between anterior part of choanae; tongue sub-circular, as long as wide, notched behind (males with elongate, rather anterior vocal slits and a very ample vocal sac visible externally).

Arm moderately long, the wrist reaching beyond the tip of snout; inner fingers about one fourth webbed, the outer fingers nearly two-thirds webbed; subarticular tubercles of outer finger bifid; inner metacarpal tubercle elongate, $2\frac{1}{2}$ times in length of first finger; palmar tubercle tripartite, not especially distinct; no distinct fold or row of tubercles under arm; heel reaches to the anterior edge of eye or between eye and nostril; toes four-fifths (or slightly more) webbed; a distinct inner tarsal ridge; inner metatarsal tubercle rather small, about four times in length of first toe; outer tubercle small; finger discs as large as tympanum.

Skin above moderately smooth (under a lens a fine corrugation is visible) and on the sides the skin is finely wrinkled; chin and breast lacking granulation; venter strongly granulate as is under surface of thighs; anal flap short, the vent high followed by a vertical groove flanked by a swollen tubercular ridge which terminates in a group of partly fused tubercles; practically no axillary web present.

Color: Above, the ground color is creamy white surmounted by a dark hourglass figure, sharply truncate anteriorly but extending on each side nearly to outer edge of eyelid; posteriorly the figure is irregular, there being several small dark spots scattered on rump; a few small yellow points on the dark figure; a dark stripe covers the end and side of snout and continues back along the side to groin; a cream white spot below eye; dorsal exposed surfaces of limbs banded with darker; entire thigh without pigment; humerus, save for a narrow stripe, without pigment; venter yellowish as are the concealed parts of the limbs.

*Measurements in mm. of K.U.M.N.H. Nos. 24719 ♂ and 24694 ♀ * respectively:*—Snout to vent, 27, 32; width of head, 8.6, 10.1; length of head, 7.6, 9.2; length of eye, 3, 3.2; length of snout, 2.3, 3.25; arm, 16, 20.2; hand, 7, 11; leg, 40, 52.5; tibia, 14.3, 18.3; foot and tarsus, 18, 26.

* Both specimens are from Turrialba.

Remarks: There is considerable variation in the shape and color of the dorsal dark spot. In a few cases the surrounding was darker than the spotting; in a few specimens the contrast between the spot and the ground color was slight and in one or two cases the specimens were uniform brownish.

Specimens were found on the farm of the Inter-American Institute of Agriculture at various times. The first discovery was on June 28. A large breeding population appeared near the central buildings after rains on July 2. Although relatively few females were taken, a series of more than a hundred was collected. Eggs were placed (almost invariably) on the underside of leaves or sticks out of the water, some at an elevation of as much as six feet; a second breeding group was found about three hundred yards from the first congregation in a pool in a coffee planting.

In 1951 I obtained a few specimens from the pond on the Farm, but no breeding population was heard during the summer.

Hyla phlebodes Stejneger

Figure 64

Hyla phlebodes Stejneger, Proc. U. S. Nat. Mus., vol. 30, pp. 817-818 (type locality, San Carlos, Costa Rica; Burgdorf and Schild coll.).

Hyla underwoodi Stuart, Univ. of Michigan, Mus. Zool. Mich. Publ., no. 29, 1935, p. 39 (*part.*).

Diagnosis: Small light-colored frogs with distinct irregular markings of dark brown on the back, but lacking a light-edged lateral brown stripe from snout to groin; tympanum distinct but covered with pigmented skin; eye length equals snout length; heel to eye or to between eye and nostril; a thick rounded inner tarsal ridge; vomerine teeth between choanae; proximal phalanx of fourth toe considerably wider than in other digits.

Description of species: Diminutive frogs, snout-to-vent 24 mm. ♂; width of head (8 mm.) greater than length (7 mm.); canthus rostralis distinct but rounded; top of head as far forward as nostril, flat, without depression; area about nostrils not or scarcely swollen; loreal region not or scarcely concave, sloping obliquely to mouth; nostrils not terminal, the snout, in profile, rounded, projecting one millimeter beyond mouth; tympanum distinct, pigmented, its upper edge covered by a fold from eye, which curves down behind the tympanum and continues back an indefinite distance on side; diameter of tympanum (1.25 mm.) contained in length of eye (3 mm.) approximately 2.5 times, tympanum separated from eye by 2.3 mm.; length of eye a little longer than length of snout (2.6 mm.); width of an eyelid (2.5 mm.) equal or slightly greater than interorbital

distance; vomerine teeth in two fasciculi between middle of choanae, separated from each other by a shorter distance than from the choanae; palatal glands opening into a groove, distinctly closer to choanae than to front of palate; tongue distinctly broader than long, not or very slightly emarginate and not free behind; large vocal slits near jaw, partly covered anteriorly by tongue; external vocal sac indicated by ample folds; seemingly the sac partially divided transversely into an anterior and posterior part.

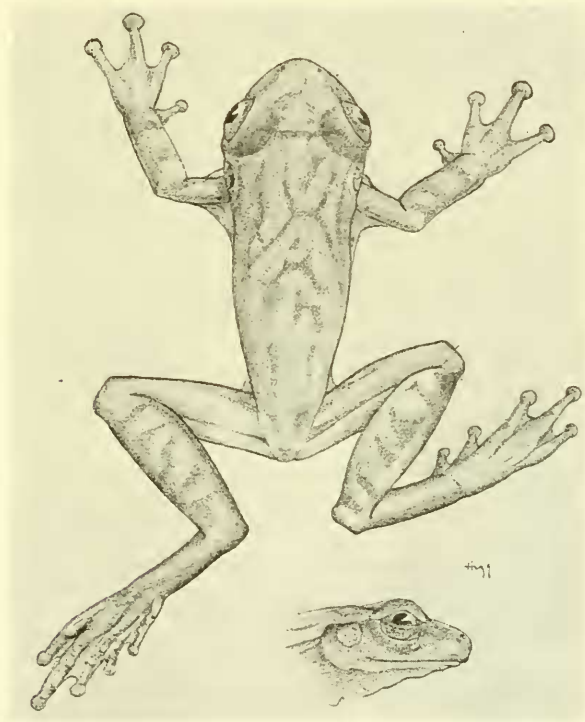


FIG. 64. *Hyla phlebodes* Stejneger. K.U.M.N.H. No. 25729; Turrialba, Costa Rica; actual snout-to-vent length, approx. 24 mm.

Arm moderately long, the wrist reaching tip of snout; digits with broad discs, larger than tympanum; a vestige of a web between first two fingers; other fingers approximately one fourth webbed; fold under arm obsolete; subarticular tubercles large, single, except one on outer finger which may be bifid; supernumerary tubercles indicated, but not very distinct; a large inner metacarpal tubercle at base of first finger, above which is a small

nuptial swelling, but seemingly lacking nuptial asperities of any sort; palmer tubercle rather indistinct, tripartite.

Leg short, the heel reaching to middle of eye; heels overlap when legs are folded at right angles to body; toes with discs smaller than those on outer finger; toes wide, the proximal joint very much widened on the fourth toe; toes three-fourths webbed, the webs not reaching discs; subarticular tubercle present, large, flattened; no outer tubercle visible; no fringe on outer side of outer toe; no inner or outer tarsal folds.

Skin generally smooth on dorsal and lateral surfaces of head and body except for some very fine irregularities and occasional minute pustular tubercles; chin and breast smooth, venter covered with small granules; under face of thigh with much larger flat granules while area about vent is smooth; vent with a short, broad, anal flap; glandular areas just behind vent swollen, with a median groove between; a well-developed axillary web; vocal sac with vermiculate folds externally.

Color in life: Generally whitish cream above with a few irregular brown reticulations on head and body; femur yellow, mostly without dark pigment; throat and vocal sac bright yellow; venter yellowish cream; no lateral dark stripe, light edged above; iris of eye blackish; some pigmentation in anal region; no pigment on web of hand; some pigment on under side of outer toes.

Measurements in mm.: Snout to vent, 24; width of head, 8; length of head, 7; length of eye, 3; tympanum diameter, 1.25; snout length, 2.6; arm, 15; hand, 7; leg, 35.5; tibia, 12; foot and tarsus, 16.

Remarks: The type locality of *Hyla phlebodes* is San Carlos, Costa Rica, presumably the Commandancia de San Carlos at the junction of the Río Arenal and Río San Carlos in northern Costa Rica.

In certain of my previous publications I have followed Dr. L. C. Stuart in considering *Hyla phlebodes* Stejneger a synonym of *Hyla underwoodi*. Having acquired a series of specimens of the former from Costa Rica, it becomes most evident to me that two distinct species are involved. *Hyla underwoodi* Boulenger belongs in a different species group of the genus *Hyla*, characterized by a broad brown stripe along the sides of head and body bordered above by a white, yellow or silver colored line. In this group are the Central American species *Hyla microcephala* Cope from Chiriquí, Panamá, which may or may not be distinct from *underwoodi*, and *Hyla robertmertensi* Taylor from Chiapas, Mexico.

Altogether, eleven specimens of *H. phlebodes* were taken at Turrialba (altitude about 1995 ft.). These were all solitary males whose presence was made known by their feeble calls. Four were obtained from weeds growing in a shallow pond near the Inter-American Institute of Agricultural Sciences. In the pond, numerous individuals of *Hyla loquax* Gaige and Stuart also were calling. Seven other *phlebodes* were taken in high grass and weeds in the environs of the pond. Here, at the same time, *Hyla eleachroa* and *Hyla ebraccata* were found breeding in shallow rain-pools.

Cope's *Hyla microcephala* from mountain streams in the Department of Chiriquí, Panamá, is described as having fingers free, toes almost fully webbed to discs; tympanum one third of the eye; eyes prominent; heel beyond end of snout; discs not as large as tympanum; a narrow brown band on each side of the back and a lateral [dark] band white-edged above; body slender with a small head. These are characteristics which do not agree with those of *Hyla phlebodes*.

I have examined two small frogs of this group from Barro Colorado Island, Canal Zone (A.M.N.H. Nos. 40470-71). Superficially they resemble *Hyla phlebodes* but the following differences are in evidence: Eye golden (in preservation); sides of snout and body with a broad stripe darker than dorsum bordered above by a light line; eyes more prominent; discs on fingers and toes smaller, not equal in size to tympanum; dorsal and posterior part of thigh covered regularly with finer black dots; toes webbed almost to discs, the webs somewhat emarginate; the proximal phalanx of the fourth toe not equally widened; there is a trace of an inner tarsal fold; some indistinct darker markings on silvery gray dorsum. This is possibly the form that has been reported from Barro Colorado as *Hyla underwoodi*. I have examined no specimens of *underwoodi* from Costa Rica.

Hyla underwoodi Boulenger

Figure 65

Hyla microcephala Boulenger, Proc. Zool. Soc. London, 1898, p. 481, pl. 39, fig. 3 (type locality, Bebedero, Costa Rica, coll. Mr. Underwood; *non* Cope 1886).

Hyla underwoodi Boulenger, Ann. Mag. Nat. Hist., ser. 7, vol. 3, Apr. 1899, p. 277 (new name for *Hyla microcephala* preoccupied); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 278; (?) Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1933, pp. 413, 420 (this is very probably *Hyla phlebodes*); *idem*, vol. 8, 1933, pp. 64, 72 (probably *H. phlebodes*); Stuart, Univ. Mich. Mus. Zool. Misc. Publ. No. 29, 1935, p. 39 (*part.*); Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, p. 85 (*part.*).

Despite the statement of Stuart (Univ. Mich. Mus. Zool. Misc. Publ. No. 29, 1935, p. 39) that Mr. Parker of the British Museum had compared a specimen of *Hyla phlebodes* Stejneger with the type of *Hyla underwoodi* Boulenger and that he "states that differences, such as the slightly greater extent of the webs on the fingers in the type are 'trivial'," it would appear that two different species of frogs are involved. Boulenger's statement of color, "pale brown above uniform or with scattered brown dots" suggests that the two forms are present in the type series. The general color and markings of *phlebodes* set it apart very distinctly from *underwoodi*. *Hyla*



FIG. 65. *Hyla underwoodi* Boulenger. Copied from Boulenger, Proc. Zool. Soc. London, 1898, pl. 39, fig. 3; Bebedero, Costa Rica; actual length, 28 mm.

underwoodi Boulenger, *Hyla microcephala* Cope and *Hyla robertmertensi* Taylor are a closely related group of species, and *Hyla phlebodes* with little or no change occurs with them from Costa Rica to Guerrero in Mexico. It is possible that it occurs also in Panamá, but I have not examined specimens from there. Smith (1938) and Smith and Taylor (1948 *loc. cit.*) followed Stuart in placing *phlebodes* as a synonym.

With the acquisition of a series of *phlebodes* from Costa Rica and a comparison with the figure and description of *underwoodi*, I believe there is no question of the distinctness of the two forms in Costa Rica, the type locality of both.

Diagnosis: A small (28 mm.) rather slender frog, the head approximately the width of the body (save in gravid females); fingers one-third webbed; eye length equals snout length; distinct canthus; tympanum length half of eye; toes nearly entirely webbed; pale brown above, uniform or with fine dots or flecks; a dusky stripe from snout tip along side of head and body, usually edged above with lighter color; thighs lacking pigment.

Type description: Tongue circular, slightly nicked, and moderately free behind; vomerine teeth in two small groups between the choanae, as long as the diameter of the orbit; canthus rostralis distinct; loreal region slightly oblique; interorbital space broader than the upper eyelid; tympanum distinct, half the diameter of the eye. Fingers one-third webbed; discs quite as large as the tympanum; subarticular tubercles moderate. The tibiotarsal articulation reaches between eye and tip of snout.

Skin smooth above and on the throat, granular on the [ventral surface of] body. Pale brown above, uniform or with scattered dark brown dots; a dark brown streak on each side of the head and belly, passing through the eye and edged with whitish above; thighs pigmentless; white beneath. Male with a large external vocal sac.

Remarks: The group to which the species belongs includes *Hyla picta* (Günther), *Hyla robertmertensi* Taylor, *Hyla microcephala* Cope, and *Hyla smithi* Boulenger. *Hyla picta*, while strongly allied to the group, lacks vomerine teeth, and these are often absent in younger specimens and perhaps some adults of *Hyla smithi*.

Hyla albomarginata Spix

Hyla albomarginata Spix, Animalia nova sive Species Novae Testudinum et Ranarum quas in Itinere per Brasiliam Annis, 1812, 1820 . . . 1824, 2, p. 33, pl. 8, fig. 1; p. 35, pl. 8, fig. 4 (type locality, Brasil).

Hyla albomarginata Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 356; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, pp. 284, 285 (San Carlos, C. R.); Dunn, Occ. Papers Mus. Zool. Univ. Mich., No. 151, 1924, pp. 3-4 (tadpoles may be another species *fide* Dunn 1931); Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 1931, p. 401; *idem, ibid.*, Oct. 1931, p. 414; Wettstein, Sitzb. Akad. Wiss. Wien Math.-Natur. Kl., Abt. 1, Bd. 143, Heft. 1 and 2, 1934, p. 8 (Hamburg farm, lower Reventazón River).

Hypsiboas albomarginata Cope, Proc. Amer. Philos. Soc., 1886, vol. 23, p. 273 (Nicaragua, Bransford coll.); U. S. Nat. Mus. Bull., 32, 1887, p. 13.

Diagnosis: This species may be diagnosed by the following characters: rather large species, 45 mm. (reported 60 mm. in Brazilian species), the very light dorsal coloration (yellowish or pinkish in life), whitish flesh with small black dots when preserved;

(dots rarely segregated into small dark spots); concealed parts of limbs without pigment; ventral surfaces whitish; fold on vent and outer edge of foot with a white stripe; at least occasionally a white stripe above tympanum along side of body for some distance; first finger with a well-developed pollex rudiment in the males bearing a sharp exposed spine.

Description of species: Head broad; snout broad and depressed with a somewhat pointed nose, the canthus rostralis indistinct or absent, the loreal region sloping obliquely; a curving fold above tympanum; length of eye greater than its distance from nostril but shorter than snout; tympanum distinct, a little longer than high, its diameter in length of eye one and one-third to one and three-fourths times; the interorbital space much wider than an eyelid; vomerine teeth between the large choanae, in two elongate diverging fasciculi placed somewhat diagonally or curving, extending behind the posterior level of the choanae, a fasciculus a little more than half as large as a choana; tongue relatively small; males with vocal slits; tip of snout rounded in profile, upper lip not notched medially; snout one and four fifths length of eye.

Arm moderate; inner fingers without web, the second one fourth, the fifth, one third webbed; discs on fingers small, not one half size of tympanum. Heel, bearing a soft tubercle or fold, reaches to nostril; toes approximately three fourths webbed, the discs smaller than those on fingers. Skin on dorsum usually rough; finely granular especially so on sides of head; a short anal flap followed by a more or less distinct groove bordered by tubercles; some specialized tubercles or granules at the side of vent; abdomen granular, chest and throat smooth; an incomplete fold across breast.

Color: General color yellowish, punctate with black dots or flecks, these slightly larger on limbs; no pigment on concealed surfaces of limbs or venter; webs on toes bright red or orange; a white line across the anal flap continued (when legs are folded) along the outer edge of leg and foot.

Remarks: I have examined specimens taken on the lower Reventazón River at La Costella but did not take measurements. I have not compared the Costa Rican form here called *Hyla albomarginata* with typical South American material. The larger tympanum, rough or granular skin, the somewhat different arrangement of the vomerine teeth, larger size, etc., suggest that the Central American and Brazilian forms are not identical. The species is known from as far north as Nicaragua. Specimens have been taken in the Lower Reventazón valley, and in San Carlos, Costa Rica.

FAMILY RANIDAE Bonaparte

Ranidae, Bonaparte, Giorn. Accad. Sci. Lett. Arti Roma, vol. 49, 1831, pp. 65, 75.

A single genus, *Rana*, is recognized in the Costa Rican fauna.

Genus RANA Linnaeus

Rana Linnaeus, Systema Natura, ed. 10, vol. 1, 1758, p. 210.

Type of the genus: (*Rana*) *temporaria* Linnaeus.

The five ranid species known from Costa Rica fall into two rather distinctive groups. The first group comprises *Rana pipiens*, *Rana maculata*, and *Rana palmipes*; the second *Rana vibicaria* and *Rana warschewitschii*. The two latter species seemingly are related to south Asian and East Indian frogs of the genus *Hylorana*, now regarded as a subgenus of *Rana* but very probably worthy of generic rank.

Certain of the species names now referred to the synonymy of the above species may prove to be worthy of recognition when adequate collections are available from their type localities.

KEY TO COSTA RICAN SPECIES OF RANA

1. Body not quadrangular in cross section; tips of toes rather pointed without terminal grooves 2
 Body quadrangular in cross section; tips of toes with or without grooves at tip 3
2. Paired lateral vocal sacs protruding near jaw angle; small puckered vocal openings, open into sacs somewhat behind and lateral to tongue; canthus rostralis rounded; heel to point between nostril and tip of snout; dorsolateral glandular fold broad; choanae large compared to vomerine tooth fasciculi; nostril nearer eye than tip of snout *pipiens*
 No vocal sacs of any kind; no vocal openings in mouth; choanae very small compared to vomerine tooth fasciculi; canthus distinct; eye nearer tip of snout than eye *maculata*
3. Larger frogs, 120 mm.; vocal sacs in males; toes nearly fully webbed with small terminal discs or pads; vocal slits; no light round spots on posterior surface of thigh *palmipes*
 Vocal sacs and vocal openings absent 4
4. Smaller slender frogs, 70 mm.; canthus sharp; snout rather pointed; rounded yellow or white spots on back of thigh; usually red color in groin and on front of thigh; lateral grooves on terminal discs *warschewitschii*
 Somewhat thicker-bodied frogs, 80 mm.; no groove on digit tips; red color often absent; no round white spots on posterior surface of thigh; snout not pointed *vibicaria*

Rana warschewitschii (Schmidt)

Figure 66

- Ixalus warschewitschii* Schmidt, Sitzungb. k. Akad. Wiss. math.-natur. Cl. Wien, Bd. 24, Heft, 1, 1857, p. 11 (type locality not stated); Denkschr. k. Akad. Wiss. math.-natur. Cl. Wien, Bd. 14, Pt. 2, 1857 (1858) pp. 241-243, pl. 1, fig. 1-4 (type locality, "Unweit des Vulcanes Chiriqui, zwischen 6000 und 7000 höhe, Panama.")
- Rana zeteki* Barbour, Occ. Papers Boston Soc. Nat. Hist., vol. 5, June 24, 1925, p. 156 (type locality, Barro Colorado Island, Canal Zone).
- Rana warschewitschii zeteki* Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, pp. 416.
- Rana warschewitschii warschewitschii* Dunn (*loc. cit.*), p. 416.
- Rana coeruleopunctata* Steindachner, Verhandl. k. k. zool.-bot. Ges. Wien, Bd. 14, 1864, pp. 264-266, pl. 15, figs. 1, 1a-1c ("Fundort unbekannt"); Boulenger, Catalogue of the Batrachia Saliencia s. Ecaudata in the collection of the British Museum, 2nd ed. 1882, p. 50, Günther, Biologia Centrali-Americana, 1900, p. 205; Boulenger, Ann. and Mag. Nat. Hist., ser. 9, vol. 3, 1919, p. 412; Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, p. 318; Boulenger, Proc. Amer. Acad. Arts Sci. vol. 55, Aug. 1920, pp. 478-480.
- Ranula chrysoprasina* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, pp. 129-130 (type locality "Arriba," Costa Rica); U. S. Nat. Mus. Bull. 32, 1887, p. 19.
- Trypheroopsis chrysoprasinus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1868, p. 117; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 114, pl. 23, fig. 12.
- Rana chrysoprasina* Boulenger, Catalogue of the Batrachia Saliencia s. Ecaudata in the collection of the British Museum, 2nd ed. 1882, p. 49.
- Hylarana chrysoprasina* Brocchi, Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 65; Steindachner, Novara, Amphib. 1867, p. 48 (not seen).

Diagnosis: A medium-sized, slender ranid reaching 57 mm. in length in females; a sharp canthus rostralis; fingers slightly spatulate at tips without a terminal groove; toes with small distinct, somewhat oval, discs, with grooves on each side of discs, but not passing around the tip; fingers lacking web; first longer than second; no vocal slits or vocal sac; toes approximately two thirds webbed. Sides of head and body nearly vertical; dorsal surface of body and head usually covered with very fine pearly tubercles.

Description of species: (K.U.M.N.H. No. 25009) Head width (15.2 mm.) slightly less than length (16 mm.); canthus rostralis sharp, the edge continued in front of nostril; tip of snout extending slightly beyond lip; head rather pointed, the tip rounded; canthus nearly vertical, not or but slightly concave; nostril lateral, slightly below canthal edge; tympanum oval, diagonally placed, its greatest diameter (4 mm.) approximately two thirds of the eye length (6.1 mm.); the distance of tympanum from eye 1.5 mm.; length of eye equals distance of eye from nostril (4 mm.); length of snout 8.4; choanae lateral, vertically placed, facing inwards; vomerine teeth in two small diagonal fasciculi separated from each other by a distance about equal to that separating them from the choanae;

palatal glands opening nearer anterior level of choanae than to anterior end of palate; tongue relatively large with two posterior projections closely approximated, free for half its length; no vocal slits.

Arm moderate, the wrist not quite reaching tip of snout; first finger a little longer than second; subarticular tubercles distinct; a large inner metacarpal tubercle; palmar tubercle large, divided

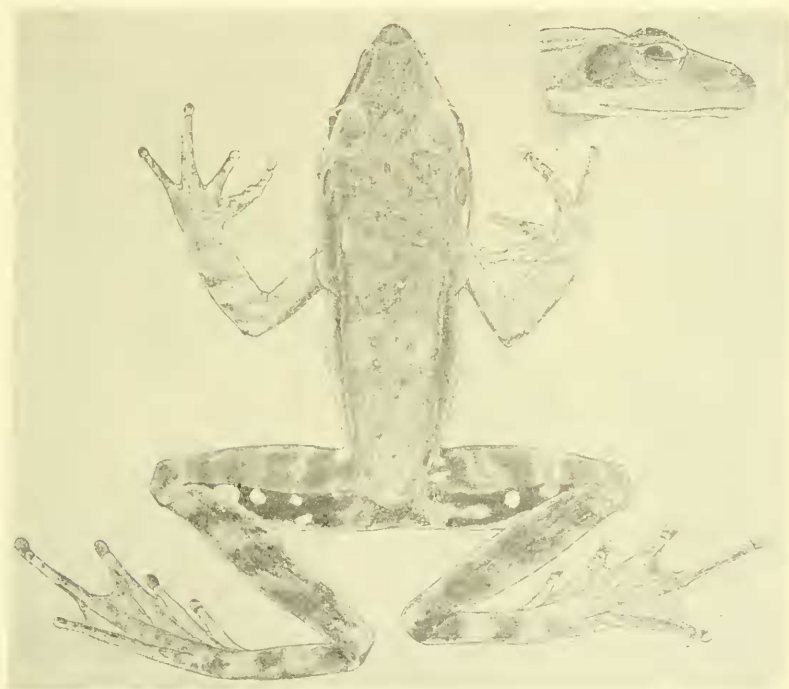


FIG. 66. *Rana warschewitschii* (Schmidt). K.U.M.N.H. No. 25009; 2 mi. SW San Isidro El General, C. R.; actual snout-to-vent length, 46 mm.

the median part largest; legs long, tibiotarsal articulation reaching tip of snout or slightly fails to reach tip. Heels overlap strongly when folded (5.5 mm.). Toes more than two thirds webbed the web reaching discs of all but fourth toe as narrow fringes; a distinct small inner metatarsal tubercle and a much smaller outer tubercle; no distinct tarsal fold, but an elongate, scarcely discernible, tarsal gland or swelling extends length of tarsus.

Skin on dorsal surface of body and head with very numerous pearly tubercles and a few larger tubercles scattered on back and on the two dorsolateral glandular folds; tubercles on dorsal surface

of tibia arranged in longitudinal rows; much of the under surface of thigh and area below vent on posterior surfaces with smooth granules; venter, chin and throat smooth.

Color: Above and on sides brown, the dorsolateral lines, due to the tiny pearly granules appearing slightly whitish; legs above brownish, barred with blackish brown, the bars extending down on the anterior surface of thigh; posterior surface black enclosing rounded light cream spots. Under surface of hand and foot yellowish; venter grayish white, upper lip cream.

Measurements in mm.: (No. 25009 San Isidro El General, on Pacific slope). Snout to vent, 46; width of head, 15.2; length of head, 16; length of eye, 6.1; diameter of tympanum, 4; length of snout, 8.4; arm, 28; hand, 12.7; leg, 74.5; tibia, 25.5; foot and tarsus, 36.

Remarks: The variation is considerable, or there are subspecies to be considered. In the material available to me there is a series of specimens from Los Diamantes, in which all the specimens have the sides of the body deep brown, while the dorsal surface is distinctly lighter brown. The cream-white streak begins under eye and continues back to arm insertion. This lies above the lighter coloration of the upper jaw edge.

A series from near Turrialba, (Morehouse Finca 4 mi. south and La Suiza, 4 to 6 miles southwest) are similar, but most of the specimens have the sides rather lighter brown than the back, although an occasional specimen has the darker brown sides. The coloration in life of such a specimen from La Suiza (R.C.T. No. 246) is as follows: above olive brown the sides uniform dark brown, arms light flesh to clay, the hand and the limbs darker, barred with darker color; a cream-yellow line on lip with a whitish line from below eye to arm insertion paralleling the former; groin red with some yellow spots; posterior thigh black with deep orange irregular spots; under side of thigh very bright orange-red extending on under side of tibia and foot; front of thigh yellowish cream flecked with red, and a dark knee spot; chin sulphur to greenish yellow with some flecks or red reticulation under arm and hand.

The elevation of the La Suiza locality is 2500 ft. more or less. A specimen taken at Isla Bonita on Volcán Poás differs very markedly from other specimens taken in the same locality. It is uniform deep bluish black, the skin lacking all trace of the fine pearl-tipped granules. The leg in life was somewhat red on the under surfaces while the two or three small spots on the black posterior

face of the thigh were yellow. The under surface of the chin, anterior two thirds of venter and anterior third of ventral part of thigh was strongly clouded with grayish black. The spot at the front point of arm insertion is well defined. The under surface of the hand and foot is blackish, with some yellowish areas. This specimen is a male with a large nuptial gland on first finger. Traces of the leg bands are visible only on the front face of the thigh. The snout-to-vent measurement is 52 mm.

A second specimen, also a male, lacks the pearly tubercles but the skin is finely corrugated or pebbled with smooth granules. It is olive brown on the dorsum and sides and the banding on the legs is distinct. The ventral surfaces are less distinctly mottled, and the white line from the eye to the arm is distinct.

A total of 54 specimens have been examined from Costa Rica. Aside from localities already mentioned is one specimen from Cartago and several from Los Diamantes near Guápiles. The species has been reported from Suretka and Navarro.

Rana zeteki, which has been regarded as a subspecies of this species, is described as follows: "A *Rana* closely related to *Rana warschewitschii* (Schmidt) = *Rana caeruleopunctata* [sic.] (auct.) and differing conspicuously in having a wholly black throat, chest and upper belly instead of an ashy-gray venter; dark, not pink, anterior aspects of the thighs; inconspicuously instead of heavily cross-barred tibia; the white stripe on the upper lip extending to beneath the eye instead of to the tip of the snout; the dorsum much less coarsely granular; the feet and webs largely black instead of largely coral pink; a distinctly shorter hind leg and more massive thigh." The type is No. 10031 M.C.Z. from Barro Colorado Island, Gatun Lake, Canal Zone (four paratypes).

Rana caeruleopunctata Steindachner^o is a species described in a work dealing with species from many localities. The type locality of this species is not known ("Fundort unbekannt"). Whether or not this species actually originated in Central America has not been decided beyond question. The description is detailed and a reasonably good figure is given. Certain characters given by Steindachner for the form, differ from those in specimens I have before me from Costa Rica, probably the most significant being, the bluegreen spotting on the dorsal surface of the body. This is distinct and extensive as shown in the figure.

^o Steindachner, Verhandl. k. k. zool.-bot. Ges. Wien, Bd. 14, 1864, pp. 264-266 pl. 15, fig. 1, 1a, 1b. 1c

Rana vibicaria (Cope)

Figure 67

- Levirana vibicaria* Cope, Proc. Amer. Philos. Soc. Philadelphia, 1894, p. 197 (type locality "Rancho Redondo, on the divide of the Irazú range"; "Isla Nueva near the head of the Río Sucio on the Atlantic side. G. K. Cherrie coll."); Günther, Biología Centrali-Americana; Reptilia and Batrachia, Feb., 1900, p. 206.
- ? *Rana godmani* Günther, Biología Centrali-Americana; Reptilia and Batrachia, Feb. 1900, p. 204, pl. 63, fig. a and a'. (type locality Río Sucio, Costa Rica, Underwood coll.); Boulenger, Ann. Mag. Nat. Hist., ser. 9, vol. 3, 1919, p. 411; and Proc. Amer. Acad. Arts Sci., vol. 55, No. 9, 1920, pp. 462-464.
- Rana vibicaria* Dunn, Proc. Biol. Soc. Washington, vol. 35, 1922, pp. 221-222, (Crater, Volcán Poás).

Diagnosis: A moderately large, slender-bodied frog measuring 70 mm. snout to vent. Snout short, wide with a sharp canthus rostralis angulated at nostril, which is nearly on the canthus; tympanum rounded, its diameter seven tenths of the length of eye opening; sides of body and head vertical; tongue deeply notched behind; slight terminal swelling on tips of toes; first finger shorter than second; toes half webbed; a thick dorsolateral glandular fold; no dermal folds or tubercles; ventral surface of body yellowish.

Description of the species: Rather large ranids, the head as wide as or a little wider than the body, but width distinctly less than head length; canthus rostralis distinct, rounded on edge, curving from eye to nostril; in front of nostril snout rather long, deflected down a little, presenting a flattened triangular area immediately in front of nostrils; tip of snout, in profile, rounded to lip, projecting distinctly beyond lip for two millimeters; loreal region somewhat concave, the upper face vertical the lower sloping obliquely to lip; tympanum large, in younger specimens its diameter about one half length of eye; in large females "tympanum nearly size of eye," length of eye greater than its distance from nostril but shorter than the length of snout; nostril approximately midway between eye and tip of snout; width of an eyelid equal to the interorbital width; a continuous dorsolateral glandular fold from eye to near end of rump; a small narrow supratemporal fold branching from it and passing diagonally down behind tympanum.

Tongue lanceolate deeply emarginate posteriorly, forming two rounded projections; vomerine teeth in two oblique series between choanae, which are about size of a tooth fasciculus.

Arm rather long the wrist reaching tip of snout; tips of fingers not or slightly swollen, the first distinctly longer than second, minutely shorter than fourth; proximal subarticular tubercles distinct; inner metacarpal tubercle elongate, palmar tubercle distinct,



FIG. 67. *Rana vibicaria* (Cope). Figure (*Rana godmani*) copied from Günther, *Biologia Centrali-Americana; Reptilia and Batrachia*, 1900, pl. 63, fig. a and a¹; Rio Sucio, Costa Rica; probably about natural size.

partly divided; no trace of webbing, and none or but slight ridges on sides of fingers; heel to a point just anterior to eye, when legs are placed at right angles to body heels touch or barely overlap; tips of toes with flattened pads, lacking terminal grooves; first toes less than half webbed; between second and third the web reaches two thirds length of second; between third and fourth the web is three fifths length of third; between fourth and fifth web reaches two thirds length of the fifth toe; the web however on all toes continued as a strong fringe to pads; an elongate inner metatarsal tubercle, a small rounded outer tubercle; no distinct tarsal fold, but a thickened tarsal ridge, the individual glandules usually visible through skin.

Skin smooth, above and below save for a few scattered pustules on dorsum, and a granular area on the mesial posteroventral part of thigh. Vent high, followed by a groove bordered by two indefinite folds.

Measurements in mm. of Rana vibicaria (type series after Boulenger, loc. cit.)

	♂	♀	♀
Snout to vent	56	80	74
Width of head	20	26	25
Length of head	19	25	23
Length of snout	7	10	9
Eye length	7	9	8
Tympanum	4	5	5.5
Interorbital width	3.5	5.5	6
Arm	35	51	43
Leg	87	122	113
Tibia	26	38	34
Foot and tarsus	27	41	37

Variation: The color above is variable; it may be brown or orange above, with or without black spots and flecks; the first finger of the males does not show the usual secondary sex characters. The measurements given by Boulenger (*loc. cit.*) differ somewhat from those of Günther (*loc. cit.*). The smallest specimen of three is regarded as a female by Günther, as a male by Boulenger.

Remarks: A series of specimens of this species was obtained at the summit of the ridge lying between Volcán Barba and Volcán Poás. A number of the specimens are recently transformed.

The synonymizing of *Rana godmani* Günther and *Levirana vibicaria* Cope was suggested by Boulenger (*loc. cit.*). The differences nevertheless are marked and may be listed as follows:

*godmani**vibicaria*

- | | |
|--|---|
| 1. First finger shorter than second | Longer than second. |
| 2. Muzzle short and wide, not projecting beyond lip border | Muzzle rather elongate, feebly projecting beyond mouth. |
| 3. Vomerine teeth absent | Vomerine teeth in oblique groups. |
| 4. Sole of foot with one inner tubercle. | Sole with an inner and outer metatarsal tubercle. |
| 5. Integument smooth | Some dorsal tubercles. |
| 6. Two rows of black spots | Spots scattered on back. |
| 7. Lips with a shaded dark border | Lips with a white or silvery stripe. |
| 8. Head wider than long | Head longer than wide. |

It is possible that two species actually are present in Costa Rica. Future collections will prove the facts beyond question. I am following Boulenger in my treatment here.

Rana pipiens Schreber

Rana pipiens Schreber, Der Naturforscher, Halle, vol. 18, 1782, p. 185, pl. 4, (type locality, Raccoon, Gloucester Co., New Jersey, U.S.A.); Kellogg, U. S. Nat. Mus. Bull. 160, 1932, pp. 203-213, figs. 1a, 24; Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, p. 98; Wettstein, Sitzungsab. Akad. Wiss. Wien, math.-naturw. Kl. Abt. 1, Bd. 143, Heft. 1/2, 1934, p. 4-5 (Finca Guayabillos, 2200 m. on Volcán Irazú, Costa Rica).

Rana halcina Daudin, Histoire naturelle des rainettes, des grenouilles et des crapauds 1803, p. 41; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum 2nd ed., 1882, p. 41; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 19 (*part.*); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, p. 198; Boulenger, Proc. Amer. Acad. Arts and Sci., vol. 55, no. 9, Aug. 1920, p. 433-434. (*part.*).

R[ana] v[irescens] austriicola Cope, U. S. Nat. Mus. Bull. 34, 1889, pp. 398-399 (Mexico); Werner, Verh. k. k. zool.-bot. Gesells. Wien, Jahrg. 1896, p. 7.

Rana austriicola Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, p. 315, pl. 15, fig. 1 (Nicaragua).

? *Rana macroglossa* Brocchi, Bull. Soc. Philom. ser. 7, vol. 1, no. 4, p. 177 (type locality, plateau of Guatemala). Brocchi, Étude des Batraciens de l'Amerique Centrale; Mission Scientifique au Mexique . . . livr. 1, 1882, p. 12, pl. 3, fig. 1-1c [I am not certain that this species should be placed in the synonymy of *Rana pipiens*].

Diagnosis: Large frogs, 80 mm. snout to vent; vomerine teeth in two fasciculi, closer to each other than to choanae, between posterior half of choanae; eye about equal to snout-length; a pair of broad dorsolateral folds extending from eye to groin but usually broken on rump; belly very feebly granulate; latter half of thighs more distinctly granulate; toes obtusely pointed more than two-thirds webbed; tarsal fold weak; strong inner metatarsal tubercles; outer small indistinct; heel reaching to between eye and tip of snout; body olive to gray, spotted strongly with black; below immaculate.

Description of species: (K.U.M.N.H. No. 121); Head elongate

oval, its length (31 mm.) distinctly greater than its width (29 mm.); eye large its length (10 mm.) greater than its distance from nostril (6.8 mm.); nostril nearer eye than tip of snout; tympanum large subcircular, its diameter (7.3 mm.) approximately three fourths of eye length; canthus distinct but rounded; nostrils swollen but with none or but a slight depression between them; upper edge of loreal region vertical, lower part sloping obliquely to lip, leaving loreal region concave; tip of snout curving from nostrils down to lip, barely extending beyond mouth; width of an eyelid (6 mm.) greater than interorbital width (4 mm.).

Tongue somewhat arrow-shaped, deeply notched, leaving two mammae-like projections posteriorly; fasciculi of vomerine teeth diagonally placed between choanae, separated from each other by a distance half as great as that separating them from choanae; vocal sacs external, posterior to angle of jaw; the small, puckered, lateral vocal openings are far back in the mouth; jaw thickened, forming an indistinct ledge below eye; an elongate glandular fold from angle of jaw to above arm; a broad dorsolateral fold on ridge from eye to end of rump usually broken behind sacrum; a few short ridges and tubercles between dorsolateral folds.

Arm rather short the wrist reaching tip of snout; first finger longer than second (much thickened at base in males), a large elongate flattened inner metacarpal tubercle at base of first finger; a large irregular, flat palmar tubercle; subarticular tubercles distinct rather low; one, two or no supernumerary tubercles; male with a large nuptial gland on base and dorsal part of first finger; toes narrowed, but rounded at tips; trace of dermal ridges on inner sides of fingers two and three.

Leg rather long, the heel reaching to nostril (sometimes to tip of snout in younger specimens); toes three-fourths to four-fifths webbed the web notched or emarginate between toes. A large metatarsal tubercle at the base of first toe, its edge compressed, free; no outer tubercle; a slight tarsal ridge on inner side of tarsus and a similar ridge indicated on outer side; subarticular tubercles elongate, slightly compressed.

Skin above rather rough with wrinkles and tubercles; two indistinct tubercular rows from sacrum meet at end of urostyle; sides finely wrinkled, with a few tubercles near the dorsolateral line; ventral surfaces smooth with a wrinkle or fold across breast; much of the posterior face of thigh and part of the ventral face with fine granules; under a lens some of these appear to be capped with a fine pearl tip.

Color: Olive above in life (brownish gray in preservative); back with two rows of dark brown spots somewhat diffuse anteriorly, discrete posteriorly; a canthal mark; two lateral rows of black spots; legs and arms with darker transverse bands with a longitudinal dark mark on left tibia; back face of femur dull yellowish brown, with heavy dark reticulation; a black mark on front of upper arm; a canthal black streak continued behind eye above tympanum. Venter and under side of limbs immaculate; under surface of foot and hands grayish.

Measurements in mm.: Snout to vent, 80; length of head, 31; width of head, 29; diameter of tympanum, 7.2; length of eye, 10.3; length of snout, 14; arm, 50; hand, 21; leg, 134; tibia, 45; foot and tarsus, 66.

Remarks: All specimens are brownish olive with black spots on dorsum in two to four rows. The vomerine teeth are variable; sometimes arranged diagonally, converging toward the median line; sometimes the groups are practically transverse. The size of the groups varies. Some are no larger than the choanae, others are one and one-half times the size of the choana; the proportional size of the choanae vary but little. The ventral coloration is similar in all.

The subspecific forms of *Rana pipiens* are not considered here. It is very difficult to find sufficient fixed characters to distinguish this form from its near relatives in Mexico and elsewhere. The form has been distinguished under the name *R. austriicola*.

Rana maculata Brocchi

Rana maculata Brocchi, Bull. Soc. Philom. ser. 7, vol. 1, No. 4, p. 178 (type locality Totonicapam Guatemala); Étude des Batraciens de l'Amérique Centrale, Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 1, 1881, p. 13, pl. 3, figs. 2, 2c.

Rana vivescens austriicola Werner, Verh. k. k. zool.-bot. Gesells, Wien, Jahrg. 1896, p. 7 (*part.*).

Rana pipiens Kellogg, U. S. Nat. Bull. 160, 1932, pp. 203-213 (*part.*).

Rana halcina Boulenger, Proc. Amer. Acad. Arts Sci., vol. 55, No. 9, Aug. 1920, pp. 433-443, (*part.*).

The presence of a frog on the Caribbean side of Costa Rica related to *Rana pipiens* but differing from it specifically is attested to by three specimens from Peralta, Costa Rica. Superficially they would seem to belong to *Rana pipiens* but their general habitus, details of coloration, the absence of the lateral vocal sacs in the male as well as the absence of the small, puckered, vocal perforations far back in the mouth near the jaw angles, all prove the presence of a distinct species. Occurring also in Costa Rica

is a species much more frequently encountered that does belong to the *Rana pipiens* complex. Specimens of the latter species were taken above Isla Bonita (7500 ft.) Volcán Poás at Turrialba, Cartago. Moravia and at San Isidro on the Pacific lowland.

By direct comparisons of two specimens one of *maculata* and a specimen of *pipiens* from Turrialba the following structural differences are discernible:

- | | |
|---|------------------------------------|
| 1. Diameter of choanae in distance between, 7-8 times | 1. Approximately 4 times |
| 2. Vomerine tooth fasciculus size of choana | 2. 1½ times |
| 3. Palatal groove midway between vomerine teeth and end of palate or nearer the teeth | 3. Nearer anterior end of palate |
| 4. No vocal opening or external sac | 4. Vocal openings and external sac |
| 5. Ridge on inner side of 2 and 3 finger | 5. Less distinct |
| 6. Hand and foot smaller | 6. Hand and foot larger |

Diagnosis: Related to *Rana pipiens* but differing in having very small choanae several times smaller than vomerine tooth groups; absence of vocal slits or openings; smaller hands; mottled or spotted ventral coloration; posterior face of thighs black, with white dots or vermiculations.

Description of species: (From K.U.M.N.H. No. 2978 Collected by Marco Tullio Pacheco, at Peralta C. R.) Snout to vent 75 mm.; width of head (27 mm.) approximately equal to length (26.8 mm.); canthus rostralis distinct to nostril and some angularity evident anterior to nostrils; latter nearer eye than tip of snout; areas about nostrils not or but slightly swollen; tympanum diameter (6.5 mm.) approximately three fourth eye length (8.3 mm.); length of snout 11 mm.; snout oval, in profile sloping to lip; upper loreal region vertical somewhat concave, lower part sloping obliquely to lip edge, the skin on jaw seemingly thickened and continued under tympanum to behind jaw angle as a continuous skinfold; a dorsolateral glandular fold from eye to behind sacrum followed in line by some elongate tubercles; a branch from this fold runs down diagonally behind the tympanum almost contiguous with the fold from upper jaw; eyelid wider than interorbital interval; tongue somewhat cordiform with two rather widely separated posterior horns, and free for half its length; vomerine teeth in two large transverse fasciculi separated from the tiny choanae by one third length of one fasciculus and from each other by less than half that distance;

diameter of choanae in distance between them approximately 8 times; (male without vocal slits or openings).

Arm rather slender, the skin shining smooth; first finger longer than second; an elongate flat inner metatarsal tubercle; dorsal part of first finger with a nuptial area (not unlike that in male) covered with fine nuptial asperities; subarticular tubercles distinct; three supernumerary tubercles on palm; two large palmar tubercles the inner rounded somewhat the outer elongate; trace of lateral ridges on fingers; more pronounced on inner edges of second and third fingers.

Legs rather short, the end of heel reaching the tip of snout; a light-colored tarsal fold or ridge present; inner metatarsal tubercle compressed with a free edge; toes four-fifths webbed the web somewhat emarginate between toes; no outer metatarsal tubercle; subarticular tubercles elongate, compressed.

Skin generally smooth with some dorsal irregular ridges between dorsolateral lines; a few irregular tubercles on sides; venter smooth, lower part of posterior face and posterior part of ventral face of thigh very finely granular, the granules each with a minute pearly tip; vent opens at upper level of thigh; dorsal surface of tibia and tarsus and area lateral to and above vent with minute pearly spinules.

Color: In preservation dark brown, with two series of rather large spots on dorsum, the first pair smallest on inner part of eyelid; sides with two rows of spots the ground color growing lighter low on side; venter dirty white with numerous gray-black or black flecks, or marbling, on chin, breast, and under side of arms and legs. Under surface of hands and feet black; a black loreal line continued behind eye; upper surface of arm and leg dark with black spots; posterior face of thigh deep black with small white or light lavender spots or vermiculations.

Measurements in mm.: Snout to vent, 75; length of head, 26.8; width of head, 27; length of snout, 11; diameter of tympanum, 6.5; length of eye, 8.3; arm, 43; hand, 17; leg, 125; tibia, 42; foot, 41; tarsus, 21.

Remarks: The three specimens of this form are all from Peralta, collected by Prof. Marco Tulio Pacheco and presented to the Museum Collection.

Whether this is actually identical with Brocchi's *maculata* cannot be determined until the type is re-examined critically.

Rana palmipes Spix

- Rana palmipes* Spix, Animalia Nova, sive species novae testudinum et ranarum quas in itinere per Brasiliam 1824, p. 5, pl. 5, fig. 1. (type locality, Brazil); Boulenger, Catalogue of the Batrachia Saliencia s. Ecaudata in the collection of the British Mus., p. 48; Ann. and Mag. Nat. Hist., ser. 6, vol. 2, 1888, p. 40; *idem*, vol. 8, 1891, p. 453; Cope, U. S. Nat. Mus. Bull. No. 32, 1887, p. 19; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, pp. 202-203. (México; Verapaz, Guatemala; northern parts of tropical America); Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, p. 316, pl. 14; Kellogg, U. S. Nat. Mus. Bull. 160, 1932, pp. 200-202; Boulenger, Proc. Amer. Acad. Arts Sci., vol. 55, No. 9, Aug. 1920, pp. 473-477; Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, pp. 98-99.
- Ranula brevipalmata* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1874, p. 131; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1870, p. 114 (Pico Blanco, C.R.)
- Rana vallianti* Brocchi, Bull. Soc. Philom., ser. 7, vol. 1, 1877, p. 175. Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1882, p. 11, pl. 2. (type locality, Mullins River near Belize, British Honduras).
- Rana melanostoma* Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, pp. 203-204, pl. 63, fig. B (*vide* Boulenger); (type locality, Dueñas, Guatemala, and Hacienda Rosa de Jéricho, 3250 ft. Nicaragua).

Diagnosis: A large frog, snout to vent 110 mm.; vomerine teeth in small oblique groups equally spaced between the posterior borders of choanae; eye large, very prominent; heel to a point between eye and snout tip; toes with small terminal discs, usually nearly fully webbed; no tarsal fold; inner metatarsal tubercle elliptic; no outer tubercle present; males with vocal slits; a glandular dorso-lateral fold from eye to near femur; belly smooth. In life, anteriorly greenish, the body brownish or grayish posteriorly.

Description of species: (R.C.T. No. 78 from Turrialba, C. R.) Body elongate, the head oval, wider than body, its length (44 mm.) greater than its width (39 mm.); tympanum large, (10 x 8.5 mm.) the greatest diameter diagonal; length of eye (12 mm.) slightly greater than distance from nostril (10 mm.), shorter than snout (16 mm.); canthus rostralis distinct, rounded, the loreal region concave; nostrils on line of canthus, prominent; a slight, broad, medial, longitudinal depression on snout, continued to between nostrils; upper part of loreal region nearly vertical, lower part sloping obliquely to lip; upper jaw thick, somewhat elevated; width of an eyelid approximately equal to interorbital width; nostril closer to eye than to median point on upper lip; snout projecting slightly.

Choanae transverse; vomerine teeth in two diagonal fasciculi, situated between and extending slightly behind choanae, separated from each other by a distance equal to that separating them from choanae; tongue arrow-shaped, deeply notched behind between

two long projections. (No trace of vocal sac or vocal slits in males).

Arm moderately slender, the wrist barely reaching tip of snout; fingers slender, very slightly swollen at tips; first finger a little longer than second, about equal in length to fourth, thickened at its base by the inner metacarpal tubercle; palmar tubercles obsolete or small; no web on hand but distinct lateral ridges on each digit; heel reaches anterior edge of eye; when legs are folded at right angles to body, the heels touch or barely overlap; tips of toes swollen and somewhat dilated at tip; toes fully webbed; a small inner metatarsal tubercle; outer metatarsal tubercle obsolete; distinct fringe or fold on outer edge of fifth and inner edge of first toe; sub-articular tubercles distinct; a tarsal ridge, somewhat rounded.

Skin above with a pair of dorsolateral glandular folds extending from orbit to near groin (often continued to end of body), none or the merest trace of a posttympanic fold; back with very minute pearly-tipped spinules intermixed with larger similar tubercles; tubercles on tibia tending to form three longitudinal lines; ventral surfaces smooth (or in males with very numerous fine tubercles); an area of indistinct granulation below vent; anal flap very short, the vent high, on dorsal level of thigh.

Color: Anterior part of body greenish especially on head and shoulders; brownish or bronze on the posterior part of body and on limbs; dorsolateral fold colored like body; numerous small flecks of black on dorsum; sides gray or gray-brown with numerous rounded black spots; posterior aspect of thigh black, reticulated with cream; legs indistinctly barred with darker; under surface dirty yellowish white, somewhat clouded with darker; under side of foot dusky.

Measurements in mm.: (from R.C.T. No. 78 ♀.) Snout to vent, 114; width of head, 39; length of head, 44; tympanum, 10 x 8.5; length of snout, 16; arm, 58; hand, 27; leg, 162; tibia, 53; foot and tarsus, 76.

Remarks: This large species was found at Turrialba in a small artificial lake on the grounds of the Inter-American Institute of Agriculture. Here it was common. Specimens were taken also at Moravia in a small pond.

FAMILY MICROHYLIDAE Parker

Microhylidae Parker, Monograph of the Frogs of the Family Microhylidae, London, 1934, p. 19.

The family Microhylidae, comprising the narrow-mouthed toads, a group specialized largely for burrowing, is rather meagerly represented in North America; only two genera, *Microhyla* and *Hypo-*

pachus, being recognized north of Panamá. Five other genera occur in South America.

Both genera are represented in Costa Rica and both are rather widespread in the Western Hemisphere. *Hypopachus* is known from Texas southward through Mexico and Central America to South America where it extends to Bolivia, Paraguay and Brazil. The greatest amount of speciation in the genus seems to have taken place in southern Mexico and northern Central America. *Microhyla*, as now interpreted, has representatives in the Western Hemisphere from Nebraska and southeastern United States, south into Mexico and Central America; in South America it reaches Ecuador and southern Brazil. The genus likewise occurs in South Asia.

Until Parker's 1934 revision of the Family Microhylidae appeared, a third genus, *Glossostoma*, was recognized for the species *aterrium*; but Parker has shown that it is merely a large species of *Microhyla* and the most primitive of the American forms of that genus.

Microhyla pictiventris, known from Nicaragua, a small (22.5 mm. long) species characterized by a black venter bearing large cream spots, is reported by Dunn (1949) from Costa Rica (Atlantic lowlands without specific locality).

The Microhylid frogs are largely burrowing, and while rarely seen may be recognized by their call, a "baa-a-a" which is characteristically reminiscent of the call of sheep and goats, though lacking the force of the call of those animals.

The heads of these amphibians are very small in proportion to the size of the body and the snout is much reduced. The metatarsal tubercles on the feet are enlarged and seem to be adapted for burrowing.

GENUS HYPOPACHUS Keferstein

Hypopachus Keferstein, Nachricht. könig. Ges. Wiss. Georg-Augusts Univ. Göttingen, 1867, p. 352.

Type of genus: *Hypopachus seebachii* Keferstein [= *Engystoma variolosum* Cope].

Hypopachus variolosus (Cope)

Figure 68

Engystoma variolosum Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 131 (type locality, "Arriba," Costa Rica, Chas. N. Riotte, coll.); Brocchi, Bull. Soc. Philom., Paris, ser. 7, vol. 1, p. 192.

Systoma variolosum Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, 1867, p. 194.

Hypopachus seebachii Keferstein, Nachricht. königl. Gesell. Wiss. Georg-Augusts Univ. Göttingen, 1867, p. 352 (body length, 48 mm. including head,

6 mm.; body breadth, 35 mm.; leg, 50 mm.; arm, 25 mm. Costa Rica.); Arch. für Naturg., Jahrb. 34, vol. 1, 1868, p. 293, pl. 9, figs. 1, 2 (lateral view, and pectoral girdle).

Hypopachus variolosus Cope, Proc. Amer. Philos. Soc., vol. 11, 1869, pp. 166-167; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 101; Brocchi, Étude des Batraciens de l'Amérique Centrale; Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 2, 1882, pp. 92-93, pl. x, fig. 2 (probably only *part.*); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 159; Cope, U. S. Nat. Mus. Bull. No. 32, 1887, p. 18; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, p. 211 (*part.*) (Bebedero, and San José, Costa Rica; Mexican references are to other species); Nieden, Das Tierreich, Lief. 49, Anura II, p. 70, (*part.*); Miranda-Ribeiro, Arch. Mus. Nac. Rio de Janeiro, vol. 27, pp. 191, 226, fig. 102; Kellogg, U. S. Nat. Mus. Bull. No. 159, 1932, p. 184 (*part.*); Parker, Monograph of the Frogs of the Family Microhylidae, 1934, London, pp. 112-113 (All specimens known from Costa Rica listed); Dunn, Amer. Mus. Novitates No. 1419, May 9, 1949, p. 3.

Diagnosis: A fat, triangular body; snout extremely short; eye very small; mouth narrow; fingers without web; feet narrow with a web remnant; two large prominent metatarsal tubercles; above lavender to brown, mottled or spotted black; a dark lateral stripe; belly blackish with rounded cream spots; a light diagonal line from eye to insertion of arm; tympanum not visible; no vomerine, or jaw teeth.

Description of species: (K.U.M.N.H. No. 28338.) Head small, triangular, its width at tympanic region (8 mm.) about equal to its length (7.6 mm.); eye small, its length 3.2 mm.; snout length 4.3 mm.; eye to nostril 2.3 mm.; width of an upper eyelid (2.3 mm.) in interorbital distance (4.6 mm.) twice; tip of snout rounded extending slightly beyond mouth, and in lateral profile slopes sharply back to lip; a deep groove from eye to arm insertion; a groove crossing back end of jaw can be traced some distance across chin. Tongue broader anteriorly than posteriorly, longer than broad, free, save at its anterior end; no teeth; posterior part of choanae visible when seen from below, the remainder concealed by an overhanging shelf; a broad fleshy elevation on palate in front of oesophagus, the surface longitudinally grooved; preceding this is a narrow fleshy fold, its transverse length three to four times its width, the ends slightly free.

Arm short, fingers free, the first distinctly shorter than second; subarticular tubercles low but distinct; outer palmar tubercle largest, that at base of first finger smallest; tips of fingers not or minutely widened, the fingers rounded without trace of lateral ridges; legs very short, the toes webbed at the base (about $\frac{1}{4}$ to $\frac{1}{5}$); inner toe very short; fifth shorter than third; the tips of all digits slightly narrowed and swollen on under surface of tip; subarticular tubercles

distinct; no supernumerary tubercles on either hands or feet; inner metatarsal tubercle large, elevated, about 3 mm. long at its base, and 1 mm. high; outer tubercle smaller, a little less than 2 mm. wide at base, the two separated by about 1 mm., no tarsal ridges or tubercles.

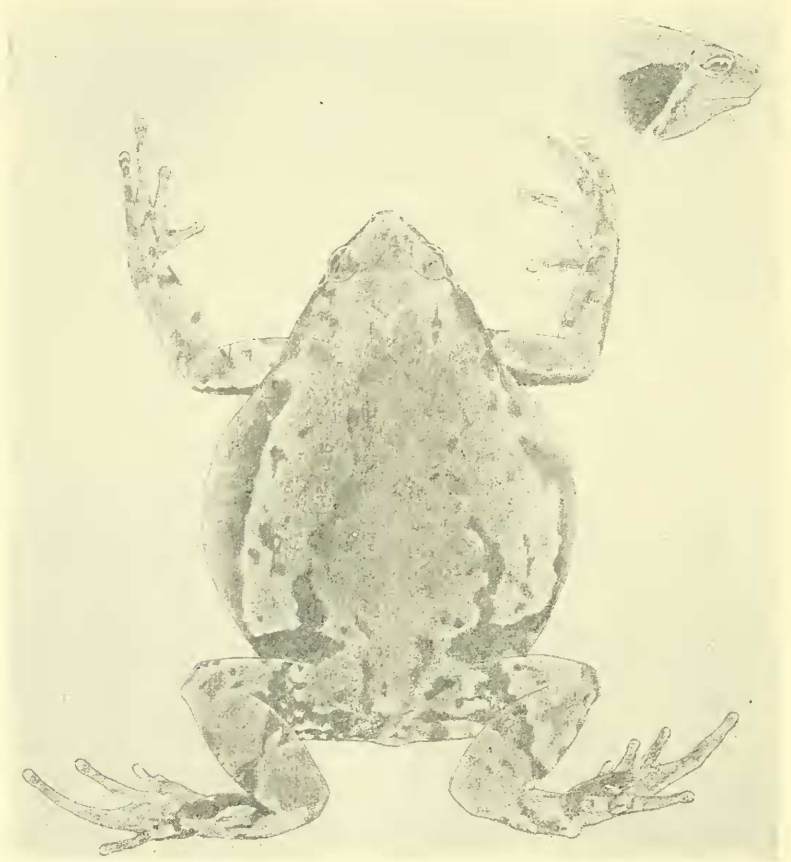


FIG. 68. *Hypopachus variolosus* (Cope). K.U.M.N.H. No. 28338; Cartago, Costa Rica; actual snout-to-vent length, 45 mm.

Skin of back thick, leathery, generally smooth, as is entire venter; region surrounding anal opening with numerous minute, spiny, pearl-tipped pustules; under a lens a few smaller pearl-tipped pustules are visible on tibia, on rump and in groin.

Color: Dorsal surface purplish or lavender-brown; a large irregular black spot in groin with an irregular broken stripe, extending

foward on back, often reaching shoulders; a diagonal dark stripe on side of head continuing above arm to groin area; bordering this above is a broad irregular stripe, lighter than remainder of dorsum; chin and throat brown to lavender; belly dark with large cream spots, often rounded; a diagonal light line from eye to arm; a black bar across folded limbs.

Measurements in mm.: (K.U.M.N.H. No. 2473.) Snout to vent length, 45; head width, 8; head length, 7.6; arm and hand, 23.7; leg, 50; tibia, 16; tarsus and foot, 27.

Variation: Certain of the specimens show a few large pustules on the back while the entire surface is covered with minute pearly tubercles. The males are light chocolate-brown above and the pearly pustules are stronger and larger, visible to the naked eye. Pustules likewise are strongly developed over the lower jaw and lip with a few bordering the upper lip. Males are lighter than females on the belly and on the anterior part of the venter. The subcircular disc on the venter is more or less defined (used in clasping) but it is seemingly entirely absent in females. The feet of the males are about half webbed, but the webbing is irregular. A scalloped fringe extends to near the tip of the fourth toe. (Males however differ among themselves in respect to the amount of webbing.) An ample, vocal sac is present in males, the vocal slits in the mouth being very large. The external skin of the vocal sac is blackish. Occasional specimens show a groove or a slight fold across head just back of orbits.

The relationship of this species is not well known. Several forms are recognized in northern Central America and Mexico. The genus also has representatives in South America.

Specimens of this species were captured along the wet streets in the environs of Cartago, Costa Rica, in small water pools after a rain. The males were calling, the voice resembling the "baa" of a sheep. Females were collected but no pairs were found clasping. When approached the animals sank under the surface of the water to the bottom where for a time they remained motionless.

GENUS MICROHYLA Tschudi

Microhyla Tschudi, Mem. Soc. Sci. Neuchâtel, vol. 2, 1939, pp. 28, 71.

Type of genus: *Hylaplesia achatina* Boie (*nomen nudum*) [= *Microhyla achatina* Tschudi].

Two species are reported as occurring in Costa Rica. One *Microhyla aterrima* is the largest species of the genus (55 mm.); the other is diminutive the type measuring 22.5 mm.

KEY TO COSTA RICAN MICROHYLA

- Larger. Color gray black to black above and below lacking white marks on ventral surfaces *aterrima*
 Smaller. Olivaceous brown above; a black band with a pale superior border from muzzle to lower part of groin; below black with large white spots on venter, and smaller white spots under hind limbs *pictiventris*

Microhyla aterrima (Günther)

Figure 69

Glossostoma aterrimum Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, pp. 210-211, pl. 64, fig. A (type locality, Costa Rica; British Mus. No. 1902.5.12.6♀; Underwood, collector); Nieden, Das Tierreich, Lief. 46, Anura II, Sept. 1926, pp. 68-69, fig. 45 (outline drawing of Günther's figure).

Gastrophryne aterrima Parker, Occ. Papers Mus. Zool. Univ. Michigan, no. 187, 1927, p. 5.

Microhyla aterrima Parker, A Monograph of the Frogs of the Family Microhylidae, 1934, pp. 143-144 (Peña Lisa, Colombia, 300 ft. and Río Durango, northwest Ecuador); Dunn, Amer. Mus. Novitates, no. 1419, May 9, 1949, pp. 16-17 (Carrillo, Atlantic lowlands of Costa Rica; Muzo, 840 m. elevation, in "the middle Magdalena forest," Dept. Boyacá, Colombia. Incorrectly gives the date, 1902 as the date of the type description).

Diagnosis: Snout rather narrowed, rounded at tip, one and two thirds as long as eye; skin of head and dorsal surface appearing smooth; eyes small, the width of an eyelid in interorbital distance $2\frac{1}{2}$ to $2\frac{3}{4}$ times; no canthus rostralis; numerous minute pearly tubercles on upper lip, the outer parts of chin, on arm, hand, foot and on posterior part of tibia; limbs short, the tibiotarsal articulation reaching to a point some distance behind tympanic region; tympanum not visible; fingers short, free of web; foot less than one half webbed. Color black above, dark grayish below.

Description of species: (from K.U.M.N.H. No. 28173.) Head distinctly wider than long; snout slightly rounded at tip; a curving fold crosses head behind eyes and a slight groove can be traced from it, across tympanic region and jaw; tympanum covered by thick skin but its outline can be discerned by its elevated edges, its diameter about two thirds of eye length; snout rounded transversely, the canthus rostralis lacking; a slight depression behind nostril; loreal region strongly oblique; length of eye-opening equal to the distance between eye and nostril, and contained in interorbital distance $1\frac{1}{2}$ times; tongue a rounded oval, free for two thirds of its length, not notched posteriorly; choanae of moderate size, widely separated, the diameter of one contained in the distance between them, four to five times; a broad transverse glandular fold across posterior part of palate, with a smaller, shorter and narrower fold immediately in front of it; no vomerine teeth.

Skin thick, leathery, appearing smooth, but under the lens numerous, small, scattered pits are evident, and skin shows minute granulations; skin on region above tympanum, and extending to above arm insertion, much thickened; surface of shin, except mesially, covered with numerous pearly tubercles, a few of which appear on upper lip; in posterior abdominal region there is a fold

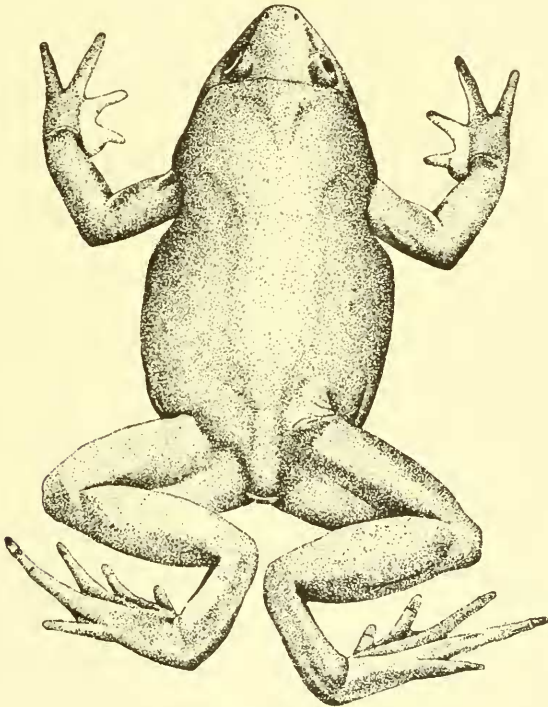


FIG. 69. *Microhyla aterrima* (Günther). K.U. M.N.H. No. 23173; 1000 m. elev. east slope Volcán Poás, Costa Rica; actual snout-to-vent length, 47 mm.

suggesting an abdominal disc, while the whole under surface of abdomen appears to be an extensive nuptial gland that terminates at throat; a few pearly tubercles below anal opening; posterior surface of arm and leg, to a lesser extent hand and foot, with numerous pearly tubercles.

Arm short, fingers tapering, the first finger shorter than second; a large flattened tubercle at base of first finger; palmar pad flattened, scarcely discernible as such; subarticular pads large, the small terminal pads narrower than the fingers; a large patch of nuptial asperities covering dorsal surface of pad and first finger,

the inner and part of the dorsal surface of the second finger and some of the dorsal surface of the hand; another patch borders the inner surface of the third finger; the extremely minute asperities are yellow-white lacking any brown color; no trace of web or lateral finger ridges.

Digits on foot with small terminal discs, narrower than digit; subarticular tubercles large, flat; a moderately large flattened inner metatarsal tubercle, but no trace of an outer; first toe free of web save for a suggestion of lateral ridges; second toe with a narrow inner fringe; between the second and third toes about one-third webbed, the fringe extending on the sides of digits; between third and fourth the web is about half as long as the third digit leaving three joints of the fourth free, the fringe continuing to near tip; between fourth and fifth the web is two thirds the length of the fifth toe.

Color: Nearly uniform black (purplish brown when preserved); chin blackish brown; abdomen dirty light yellow-brown; under side of limbs dark with some grayish clouding; under a lens minute yellow-brown dots visible under skin.

Measurements in mm.: Snout to vent, 47; width of head, at tympanum, 12; snout to dorsal head fold, 8; arm, 27; leg, 64; tibia, 22.5; tarsus and foot, 34.6.

Remarks: Parker (1927) has shown that the genus *Glossostoma* is not tenable, but that the species assigned to it represents probably the most primitive American members of the genus *Microhyla*, retaining, as it does, the largest foot web, and the palatine bone. The largest size known for the species is 55 mm. for the female type. Aside from eastern Costa Rica the species is known to occur in Colombia and northwest Ecuador.

In 1947 I found a single specimen of this species (K.U.M.N.H. No. 28173) under a small log, along an old road passing down the eastern face of Volcán Poás, at an elevation estimated to be 1000 meters. When exposed by the turning of the log the specimen remained motionless.

In 1951 I found this species to be abundant at Moravia in a pile of chips, some 16 specimens being taken at this place. One or two other animals were found in similar localities near by. However, specimens were not encountered elsewhere, and the voice was not heard. Many of the specimens were females.

Microhyla pictiventris (Cope)

- Engystoma pictiventre* Cope, Proc. American Philos. Soc. vol. 23, Apr. 1886, p. 272 (type locality, Nicaragua); U. S. Nat. Mus. Bull. 32, 1887, p. 18; Günther, Biologia Centrali-Americana. Reptilia and Batrachia, Feb. 1900, p. 209; Nieden, Das Tierreich, Lief. 49, Anura II, 1926, p. 66 (*pictiventris*). *Gastrophryne pictiventris* Stejneger, Proc. Biol. Soc. Washington, vol. 23, 1910, p. 166.
- Microhyla pictiventris* Parker, A Monograph of the Frogs of the Family Microhylidae, 1934, p. 146 (Nicaragua); Dunn, Amer. Mus. Novitates, No. 1419, May 9, 1949, pp. 16. (Nicaragua and Costa Rica).

I have had no specimen of this rare species and include data from the type description.

"One small metatarsal tubercle. Muzzle anterior to eye equal to twice long diameter of latter, and projecting well beyond the mouth. Nostrils lateral, terminal. No fold across occiput. Skin everywhere smooth. First finger shorter than second, which reaches end of muzzle when the limb is extended. When the hind limb is extended forwards the distal end of the astragalus reaches the extremity of the muzzle. First toe very short; second [third?], a good deal longer than fifth; fourth elongate. Color above olivaceous brown. A black band with a very narrow pale superior border extends from the end of the muzzle to the lower part of the groin, the superior border descending posteriorly. No inguinal spot. Below black, with white spots. Those on the abdomen are very large; those on the femora and tibia are smaller, and those on the thorax and gular region are still smaller."

Total length of head and body, 22.5 mm.; length of posterior leg, commencing at groin, 29 mm.; length of posterior foot, 14 mm.; length of astragalar portion, 4.5 mm.

The type is 14196 in the U. S. National Museum.

Remarks: The species is included on the basis of Dunn's (1949) Costa Rican report. Whether or not there are Museum specimens available, actually taken in Costa Rica, I do not know.

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- POPE, PHILIP
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 Wettstein reports three salamanders, and seventeen species and subspecies of frogs and toads. All save one (an "*Eleutherodactylus spec?*") are referred to known species.

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